THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

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Chronicle and Comment

Lindbergh

RARELY, if ever, has any event touched the heart, stirred the imagination, or strained the emotions of Americans, or of the world in general for that matter, more than did Lindbergh's lone flight from New York City to Paris. Naturally, at the meeting of the Society last month, there was spontaneous as well as keen demand for articulate recognition of the great accomplishment of the flyer, young in years but old in experience and wisdom. On behalf of the members of the Society, President Hunt cabled Captain Lindbergh a message expressing the profound admiration of the members for his heroic achievement in aviation.

Committee Reports

THE reports submitted at the Semi-Annual Business Meeting of the Society at French Lick Springs on May 25 are printed in full on p. 775 of this issue. These reports cover all phases of the Society's work and should be studied by every member. Only by so doing can the great amount of work being carried on by different committees of the Society be appreciated.

The Production Meeting

WITH the 1927 Summer Meeting now history, the Society is looking forward to the Production Meeting in September. The first 2 days of this meeting, Sept. 19 and 20, will be held at the Hotel Winton in Cleveland and the last 2 days, Sept. 21 and 22, at the Hotel Statler, Detroit. Prof. John Younger is Chairman of the Meetings Subcommittee in charge of the arrangements for this meeting and a very interesting technical program seems assured.

Buffalo Section Leads

FOR the first time in the history of the Society the membership standing of the Sections has been placed on a comparable basis, the percentage of Section members to Society members in the Section territory. On this basis, Buffalo leads with a percentage of 135 and New England and Indiana are practically tied for second place, both with a percentage of more than 100.

A rating of more than 100 per cent indicates that a Section has been active enough to draw members from outside of its territory, which is in general all territory within a 30-mile radius of the center of the city where Section headquarters are located. The Metropolitan Section has the honor of being the only Section with more than 1000 Society members in its territory, and its Section membership of 801 gives it first place on the basis of actual Section members, the Metropolitan Section having passed Detroit on April 28.

The complete report of the standing of the different Sections is given on p. 778.

The Chassis Assembling Contest

WITHOUT doubt the greatest surprise of the 1927 Summer Meeting was the driveaway of the Washington Section chassis while all eyes were on the Cleveland team, which, with engine running, was expected to win the most novel and interesting contest ever staged at an S.A.E. Summer Meeting. As several of the members of the team representing the Washington Section were from the Bureau of Standards, it cannot be said that the men engaged in scientific research are without ability when it comes to practical automotive matters.

Credit is due to John Warner, who suggested the contest, to the Chevrolet Motor Co., which made the contest possible by loaning the chassis, and to the support of the members responsible for carrying out the plans of the Contest Committee.

It is hoped that future Summer Meetings will see other inter-Section contests of a similar nature.

The Summer Meeting

IN spite of floods and thunderstorms, or possibly because of them, the 1927 Summer Meeting will go down in S.A.E. history as one of the most interesting from both a technical and sports viewpoint. The attendance of practically 800, slightly more than last year, proved the wisdom of the Meetings Committee in holding the meeting 2 years in succession at French Lick Springs.

The technical sessions were well attended in spite of the sports program that necessarily overlapped to some extent. The papers presented, a number of which appear in this issue of THE JOURNAL, well warranted the record attendance.

When the complete program on sports and entertain-

ment is looked back upon, the work falling upon the Sports Committee may be appreciated. The Summer Meetings of the Society are possible only because of the work undertaken by the Committee members at a sacrifice of their own time and pleasure.

Of special interest was the greater attendance at the Summer Meeting of the men responsible for the direction of the engineering work of the automobile manufacturers. Practically every session was presided over by a chief engineer of one of the larger automobile companies.

The complete story of the Summer Meeting will be found on p. 693 of this issue. A special effort has been made to tell the story of the meeting in pictures, in view of the notable features of the meeting.

Invitation To Visit England

THE members of the Society have been extended a cordial invitation by the Institution of Automobile Engineers and the Society of Motor Manufacturers and Traders, of Great Britain, to visit England this autumn, to attend the World Motor-Transport Congress to be held in London Nov. 14 to 16, and the International Commercial Motor-Transport Exhibition at the same place Nov. 17 to 26. Social and professional sessions of the Institution of Automobile Engineers and of the Society of Motor Manufacturers and Traders will also be held.

The main object of the Congress is to secure discussion calculated to stimulate action by governments and other bodies in furtherance of road motor-transport development throughout the world. In connection with the Commercial Motor-Transport Exhibition, conferences will be held on the subjects of railroad terminal services, retail-store distribution and functions of buses and trams. Visits will be made to various establishments and factories.

This invitation affords the members unique opportunity to make, under the best conditions, a study of the motor-transport fields indicated. In addition, there is great incentive to join an S.A.E. party making a visit of this kind. Several members have indicated their desire to make the trip. Other members interested in doing so are asked to communicate with the office of the Society.

The 1928 Summer Meeting

WITH the holding of the Summer Meeting 2 years in succession at French Lick Springs it is necessary that consideration be given to the selection of an Eastern location for the 1928 Summer Meeting. At the time the location for the 1927 Summer Meeting was discussed at the Annual Meeting, consideration was given to White Sulphur Springs, Spring Lake, Quebec, Lake Placid and Swampscott. Suggestions or comments in connection with these locations or any others will be appreciated by the Meetings Committee. Of those named, White Sulphur Springs would be unable to accommodate the Summer Meeting, owing to inadequate hotel facilities.

The following record of past Summer Meetings and the attendance is of interest:

1912	Mackinac Island Boat Trip	400
1913	Sault Ste Marie	435
1914	Cape May	370
1915	Georgian Bay Boat Trip	452
1916	Mackinac Island Boat Trip	554
1917	City of Washington	704
1918	Dayton	900
1919	Ottawa Beach	634
1920	Ottawa Beach	815
1921	West Baden	698
1922	White Sulphur Springs	561
1923	Spring Lake	804
1924	Spring Lake	732
1925	White Sulphur Springs	714
1926	French Lick Springs	787

W. G. Wall Nominated for President

THE Nominating Committee which was completed at the Business Session of the Society by the election of three members-at-large, announced during the Grand Ball the nomination of W. G. Wall for President of the Society for the administrative year beginning at the close of the 1928 Annual Meeting. The complete list of consenting nominees as announced by the committee follows:

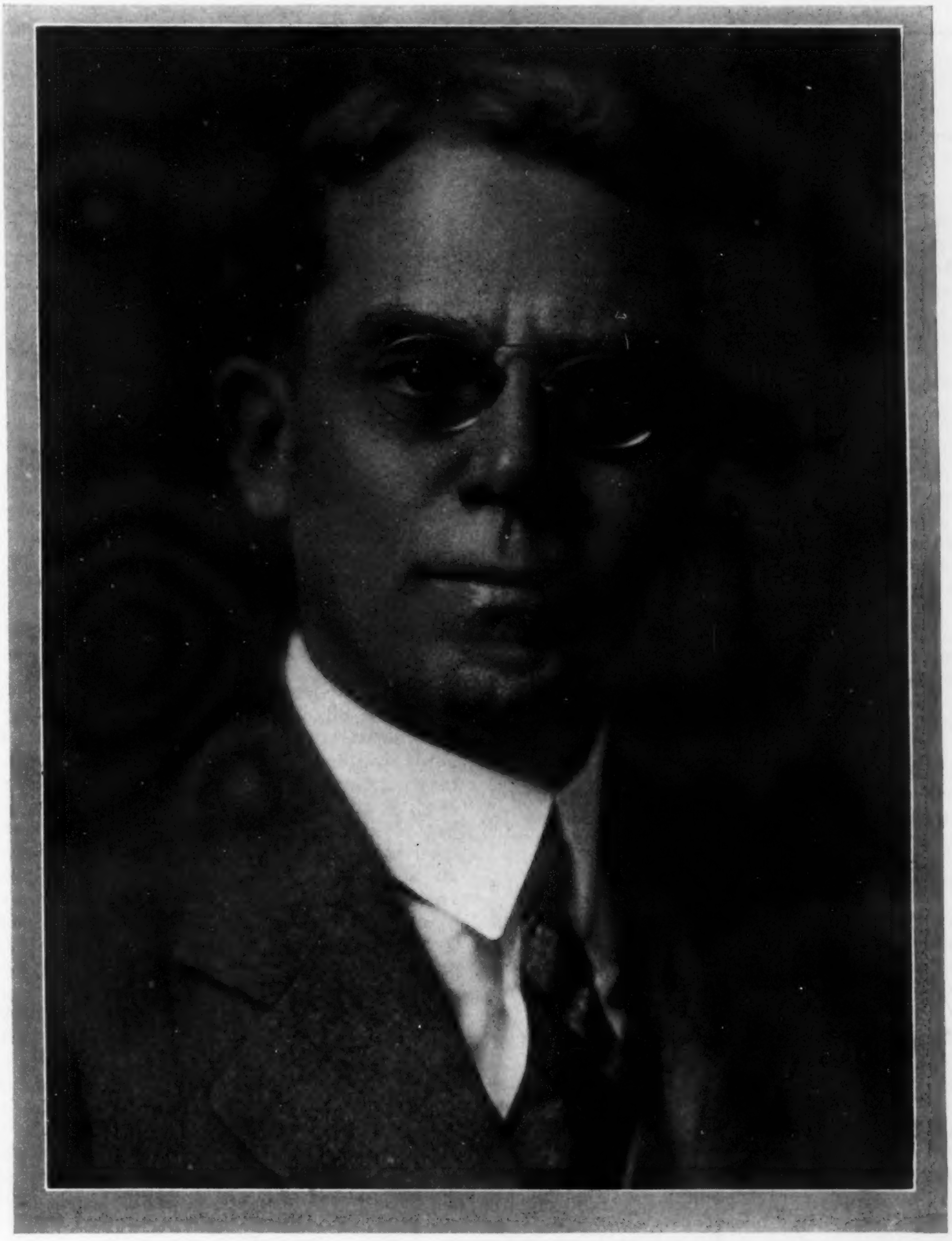
President—W. G. Wall
First Vice-President—W. R. Strickland
Second Vice-President, representing Motor-Car Engineering—Dr. H. C. Dickinson
Second Vice-President, representing Tractor Engineering—D. T. Davies
Second Vice-President, representing Aviation Engineering—L. M. Woolson
Second Vice-President, representing Marine Engineering—Harry T. Woolson
Second Vice-President, representing Stationary Internal-Combustion Engineering—C. R. Schuler
Treasurer—C. B. Whittelsey
Councilors, to serve two years—E. W. Templin, J. W. White and F. G. Whittington

The members of the present Council who will hold over as members of the 1928 Council are J. H. Hunt, as Past-President, and Councilors S. W. Sparrow, C. B. Veal and Ernest Wooler.

The Nominating Committee as organized following the Business Session consisted of

Section	*Representative*
Buffalo	John C. Talcott
Chicago	O. W. Young
Cleveland	O. A. Parker
Dayton	C. F. Rauen
Detroit	E. V. Rippingille
Indiana	Raymond F. Buckley
Metropolitan	S. R. Dresser
Milwaukee	Wm. S. Harley
New England	M. R. Wolfard
Pennsylvania	Charles O. Guernsey
Washington	A. W. Herrington
Members at Large	F. M. Germane, W. C. Keys, S. B. Stevens

The Nominating Committee was appointed in accordance with the provisions of the Constitution of the Society. The By-Laws of the Society provide for the organization of a special nominating committee. If organized, the special nominating committee shall, on or before Nov. 15, present to the Secretary of the Society the names of the candidates nominated by it for the elective offices next falling vacant, together with the written consent of each.



WILLIAM G. WALL

AUTOMOTIVE RESEARCH

The Society's activities as well as research matters of general interest are presented in this section

CARBON AND LUBRICATING OILS

Investigators Extend Research Reported at 1926 Meeting

C. J. Livingstone[1], Samuel P. Marley[2] and W. A. Gruse[3] recently completed a series of tests on the carbon-depositing tendencies of motor oils, supplementary to those reported at the 1926 Semi-Annual Meeting[4] in a paper constituting one of the valuable contributions to the technical sessions a year ago. The first investigation was concerned with conditions prevailing in passenger-car engines, the results leading to the formation by the authors of a theory explaining the relationship between certain characteristics of oils and their carbon-depositing tendencies. In the second series of tests the authors controlled the various factors to values commonly found in heavy-duty engines and in their findings confirmed the theory previously set forth. An enumeration of some of the test conditions in the two sets of experiments will serve to indicate the contrast between them. In the first tests, cylinder-head temperatures were maintained, for the most part, at from 340 to 400 deg. fahr., although in some instances this figure was raised to 450, and once to 665; in the second, the cylinder-head temperature was established at 495 deg. fahr. In the first tests the viscosity of the oils used ranged from 47 to 56 Saybolt sec. at 210 deg. fahr.; in the second, the range was from 60 to 85. The oil temperature at the pump, in the second series of tests, was held at 158 deg. fahr., a higher value than that characteristic of the first set.

The full text of the paper covering the latter part of the experimental work, prepared by the three authors and presented at a meeting of the American Chemical Society in Richmond, Va., on April 13, 1927, follows.

Carbon-Depositing Tendency of Heavier Motor-Oils

In previous papers[5] we have described an apparatus and method for estimating accurately the "carbon"-depositing tendency of motor oils. The experimental work so far presented has covered petroleum oils of light-medium and medium grades, tested under conditions corresponding to those prevailing for average automobile operation. The oils used were of different types on the market in this Country, and it was shown that the differences in their carbon-depositing tendencies were real and significant. In general, it was found that oils made from Gulf Coast crudes left in the engine only half as much carbon as was deposited by those made from Mid-Continent blends or Pennsylvania distillates or blends. By a blend is meant a mixture of a relatively light or a so-called neutral oil with "bright stock" which is a purified non-volatile residuum from a Pennsylvania or Mid-Continent crude-oil. Practically all motor oils from wax-bearing crudes must be so made to obtain the necessary viscosity. The Mid-Continent distilled oils fell about halfway between the Gulf Coastal distillates and the Pennsylvania distillates. Work done since the publication of the previous papers has shown that a typical California oil of medium grade has practically the same carbon-depositing tendency as have corresponding oils of Gulf Coastal origin.

A tentative explanation was offered for these facts, resting on the volatility, in the combustion space of the engine, of the various oils. Correlation of the engine tests with vacuum distillation tests showed that the carbon-depositing tendency increased with the average boiling-points of the oils used. In addition, the presence of an appreciable amount of material non-volatile at the cracking temperature was accompanied by a marked increase in carbon deposit. These relationships were interpreted to mean that the carbon found in an internal-combustion engine is produced from that part of the oil which does not boil away from the inner surfaces of the cylinder-head space at the prevailing temperatures. From this it was concluded that it is desirable to use an oil which combines the requisite viscosity with the ability to volatilize without cracking after it has been sprayed on the combustion-chamber surfaces. A similar correlation of the results of the engine work with the customary tests of the oils showed that there was an approximately straight-line relationship between the amount of carbon deposited per liter of oil consumed and the Conradson carbon-residue test as determined in the customary way. A tentative explanation of this relationship is offered at the end of this paper.

EXPERIMENTAL WORK

While the results obtained indicated what would be expected of oils of the medium grades when used in ordinary automotive service, it was not certain that the same relationships would apply when the heavier oils, which are ordinarily used under the more severe conditions encountered in the engines of motorcoaches and trucks, were studied. Direct experiments were made to meet this doubt. The apparatus used was that employed in the previous work, consisting of an 850-watt Delco generating-unit, so modified that every variable affecting carbon deposition was under control. The manner of making the tests was as already described[6], but the operating conditions were so changed as to simulate those prevailing in heavy-duty engines. The conditions changed were the load on the engine, the head temperature and that of the crankcase oil. The load was adjusted to give a power output from the generator of 900 watts, at which point the engine was definitely overloaded. By this overload and by control of the cooling water, the head temperature, as taken by a thermocouple in the head, was established at 495 deg. fahr. This temperature represents the upper limit for smooth operation. It was selected as a result of direct experiments on the temperature in the head of a four-cylinder engine, under full-throttle pulling a steep grade and detonating severely. By passing a limited amount of steam into the jacket surrounding the crankcase, the oil temperature at the pump was maintained at 158 deg. fahr. This is believed to correspond to the average rather than the maximum temperatures prevailing in the crankcases of heavy-duty engines. The carbureter was adjusted to supply a mixture of air and fuel in the ratio of 11 to 1, and this was maintained by careful control. This mixture-ratio was selected as probably typical of those used on the road.

The same lot of fuel, a good average grade of motor gasoline, was used for all runs. The oils selected for test were two Gulf Coast distilled oils, one of 61 and one of 80 sec. Saybolt viscosity at 210 deg. fahr., and two blended oils of Mid-Continent origin, one of 60 and one of 85 sec. Saybolt at 210 deg. fahr. The customary test-data on these oils are given in Table 1. It may be remarked that oils

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[1] Jun. S.A.E.—Industrial research fellow in petroleum technology, Mellon Institute of Industrial Research, Pittsburgh.

[2] M.S.A.E.—Industrial research fellow in petroleum technology, Mellon Institute of Industrial Research, Pittsburgh.

[3] M.S.A.E.—Director of petroleum investigations, Mellon Institute of Industrial Research, Pittsburgh.

[4] See The Journal, June, 1926, p. 607.

[5] See *Industrial Engineering Chemistry*, May, 1926, p. 502; also The Journal, June, 1926, p. 607.

[6] See The Journal, June, 1926, p. 607.

A are sold as extra-heavy and oils *B* as special-heavy products.

The procedure used in making the engine tests was that described in our previous publications. The duration of the runs was 15 hr. The amount of carbon deposited by each oil is expressed as the grams of deposit left in the engine per liter of oil consumed. This figure has been named the "carbon value." As will be seen from the data, the carbon values for both the gross deposit and for the deposit corrected for oil and ash content are given. The data are assembled in Tables 2 and 3.

TABLE 1—PROPERTIES OF THE OILS USED

Oil	Blend *A*	Distillate *A*	Blend *B*	Distillate *B*
Gravity at 100 Deg. Fahr., American Petroleum Institute deg.	24.50	19.80	23.80	18.50
Cold Test, deg. fahr..	5.00	10.00	30.00	45.00
Viscosity at 210 Deg. Fahr., Saybolt sec.	60.00	61.00	85.00	80.00
Flash-Point, deg. fahr.	415.00	385.00	440.00	415.00
Fire-Point, deg. fahr.	450.00	420.00	515.00	465.00
Conradson Carbon, per cent	0.92	0.22	1.48	0.22

TABLE 4—COMPARISON OF CONRADSON CARBON-VALUE AND OIL IN CARBON

	Blend *A*	Distillate *A*	Blend *B*	Distillate *B*
Conradson Carbon, per cent	0.92	0.22	1.48	0.22
Carbon Value per Liter of Oil Consumed, grams	7.30	4.90	9.30	5.30
Oil in Total Carbon, per cent	21.10	14.10	17.60	11.60
Oil in Head Carbon, per cent	14.70	7.90	10.00	6.50

TABLE 2—COMPARISON OF TWO EXTRA-HEAVY OILS

Run No.	Oil Used	Oil Consumption, Cc.	Gross Carbon, Grams	Wet-Carbon Value per Liter of Oil Consumed, Grams	Corrected Gross-Carbon, less Oil and Ash, Grams	Dry-Carbon Value per Liter of Oil Consumed, Grams
					Engine Condition A[7]	
C-119	Blend *A*	265.0	2.013	7.6	1.732	6.6
C-106	Distillate *A*	280.0	1.583	5.6	1.267	4.5
C-113	Distillate *A*	290.0	1.588	5.4	1.329	4.6
					Engine Condition B	
C-120	Blend *A*	205.0	1.970	9.6	1.484	7.3
C-121	Blend *A*	215.0	2.009	9.4	1.551	7.2
C-122	Distillate *A*	210.0	1.209	5.8	1.033	4.9
C-123	Distillate *A*	215.0	1.322	6.1	1.061	4.9

Duration, 15 hr. Air-Fuel Ratio, 11-1 Oil Temperature, 158 deg. fahr.
Room Temperature, 86 deg. fahr. Head Temperature, 495 deg. fahr. Speed, 1170 r.p.m. Power, 900 Watts

[7] A reassembling of the engine and an exchange of pistons occurred between the runs under Engine Condition *A* and Engine Condition *B*.

bring out the same general relationship. The blended oil in this case left one and three-quarters times as much deposit as did the distilled Gulf Coast oil. The actual ratio is 1.75. The higher ratio of carbon deposits for the special-heavy oils would be predicted from the fact that the difference between the carbon-residue values of these oils is greater than for the corresponding pair of extra-heavy oils. This is discussed below. Again it should be noted that the consumption for the two oils is practically identical.

The previously published experiments on this subject yielded an over-all ratio of about 2 to 1 for the deposits from Mid-Continent blended and Pennsylvania distilled oils, as against Gulf Coast distilled oils, all of medium viscosity. This ratio is higher than those here given, which are 1.50 and 1.75 respectively. It should be remembered that the experiments with the medium oils were made at a lower head-temperature, such as prevails in ordinary automobile driving, while the temperature here used was much higher, probably corresponding to that which obtains in heavy-duty engines. It is common knowledge that truck engines which, though using very heavy oils, are operated under heavy load and high temperature, are less troubled by carbon deposition than are passenger-cars, which operate at a lower temperature and are seldom overloaded. This fits in with the results of our experiments.

In Table 4 are presented data on the carbon-residue test and carbon value of each oil, together with figures on the content of oily material in the deposit from each oil.

DISCUSSION OF RESULTS

The data given in Table 2 for the extra-heavy oils show that the blended oil left about one and one-half times as much carbon as did the distilled oil of this grade. The actual ratios are 1.45 and 1.48 for the two engine conditions used. It should be noted that when no change in engine conditions had occurred between runs, the two types of oil gave practically the same oil consumption.

The data in Table 3 for the so-called special-heavy oils

CONRADSON CARBON-RESIDUE TEST

In the previous papers on this subject the significance of the carbon-residue test as a means of predicting carbon-

TABLE 3—COMPARISON OF TWO SPECIAL-HEAVY OILS

Run No.	Oil Used	Oil Consumption, cc.	Gross Carbon, grams	Wet-Carbon Value per Liter of Oil Consumed, grams	Corrected Gross-Carbon, less Oil and Ash, grams	Dry-Carbon Value per Liter of Oil Consumed, grams
C-105	Blend *B*	225.0	2.705	11.9	1.998	8.9
C-108	Blend *B*	240.0	2.760	11.4	2.115	8.8
C-116	Blend *B*	245.0	3.071	12.5	2.447	10.1
Average		237				9.3
C-109	Distillate *B*	225.0	1.233	5.4	1.046	4.7
C-117	Distillate *B*	240.0	1.596	7.1	1.456	6.1
C-118	Distillate *B*	265.0	1.615	6.2	1.361	5.1
Average		243				5.3

Duration, 15 hr. Air Fuel-Ratio, 11-1 Oil Temperature, 158 deg. fahr. Room Temperature, 86 deg. fahr. Head Temperature, 495 deg. fahr. Speed, 1170 r.p.m. Power, 900 Watts.

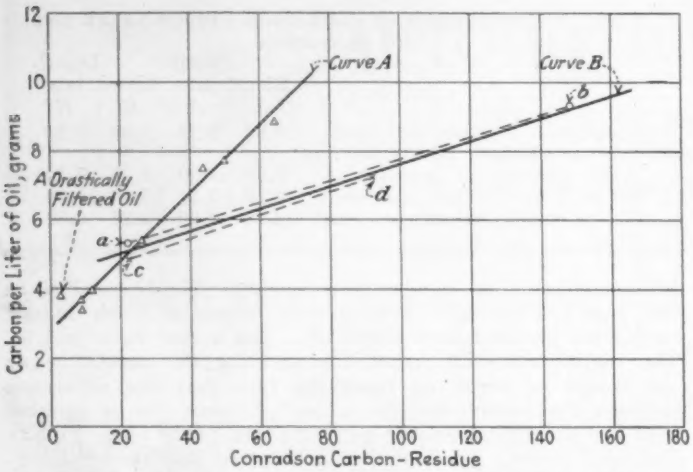


FIG. 1—PLOT SHOWING CARBON VALUE AGAINST CARBON-RESIDUE TEST-VALUES

Curve *A* Represents Data Obtained in Previous Tests for Oils of Medium Viscosity Tested at One Operating Temperature. The One Point Off the Curve Is for an Oil Clay-Filtered to a Very Pale Color. The Data for the Runs Described in This Paper Are Plotted as Curve *B*. The Suggestion Is Made That the Slope of These Lines Is Determined by the Temperatures at Which the Oils Have Been Used. The Points *a* and *b* Which Are Connected by a Dotted Line Are for Experiments with Special-Heavy Oils; the Points *c* and *d* for Those with Extra-Heavy Oils. The Temperature Was the Same for the Tests of Both Oils. The Similarity in Slope Is Thought To Indicate That the Grade of Oil Is Not the Determining Factor, and To Strengthen the Theory That the Operating Temperature Is

depositing tendency was pointed out and in one of them[3] a chart was presented showing the plotting of carbon values in grams of deposit per liter of oil consumed against carbon-residue test values. An approximately straight-line relationship was established. Only data for oils of medium viscosity, tested at one operating temperature, were used in this chart. Additional figures belonging to this set have since been obtained. The entire set of figures has been used in the construction of Curve *A* in Fig. 1. It will be seen that a straight line expresses very well the relationship involved. The one point definitely off the curve is for an oil which had been clay-filtered to a very pale color. This filtering apparently reduced the carbon residue value to a point beyond which the carbon-depositing tendency ceased to be affected. The point is, at worst, not far off the curve, and this limitation on the relationship expressed is not believed to be significant, since very few engine oils are highly filtered.

When the data for the runs described in this paper are plotted as Curve *B*, it can be seen that they fall also on a straight line differing considerably in slope from Curve *A*. It is suggested that the slopes of such lines are determined by the operating temperatures at which the oils have been used. As the operating temperature increases, it might be expected that the slopes of the curves would decrease until the lines were parallel to the horizontal axis. In other words, as temperature rises, the various oils would perhaps tend to deposit approximately the same amount of carbon. Of course, a temperature capable of producing this effect is impracticable for ordinary automobile operation.

It might have been supposed that the factor determining a change of slope would be the grade of oil used. This is probably not the case, as indicated by the dotted line joining the points *a* and *b* and that joining the points *c* and *d*. The former pair of points are for the experiments with the special-heavy oils, and the latter for those with the extra-heavy oils. These lines are approximately parallel. Since the oils are different and the operating temperatures the same, it is indicated that the temperature is the determining factor. This suggestion is given tentatively in view of the small amount of experimental data.

SIGNIFICANCE OF CARBON-RESIDUE TEST

In view of the apparent basic significance of the carbon-residue test as an indication of the carbon-depositing tendency of an engine oil, it is interesting to consider the reasons for such a phenomenon. If we analyze the conditions in the combustion-chamber of a four-cycle engine during the different phases of the cycle, the following points can be discerned.

After it has passed the piston-rings, liquid oil is sprayed into the combustion space, forming a film of liquid oil on the surface of the cylinder-head and on the face of the piston. During the intake and compression strokes, this film is exposed to low-temperature atmosphere of hydrocarbon vapor and air, containing the maximum of 19 per cent of oxygen. During the power and exhaust strokes, the temperature is higher, but the oxygen content of the atmosphere becomes almost zero. When it is remembered that the oil-film is hot enough to be blanketed by a rising layer of its own vapors, and that, furthermore, the rate of reaction between a gas phase and a liquid phase is slow, it will be seen that practically no oxidation of the liquid oil could be anticipated. It is generally agreed that combustible liquids do not burn in the liquid phase, so that whatever oxidation of oil occurs may be assumed to affect only the oil vapor which has already left the metal surfaces. Any carbon formed by such incomplete oxidation will almost certainly pass out of the combustion-chamber with the exhaust gases. Such oil as remains unvaporized will be exposed to the repeated broiling caused by the periodic explosions. At the prevailing temperature, cracking certainly occurs, and such cracking undoubtedly leaves a gummy deposit which is reduced to coke. It is to this deposition of cracking residue that we are inclined to atribute all carbon formation in gasoline engines as ordinarily lubricated. Likewise, in the Conradson carbon-residue test, the oil which will distill off has no influence on the result, while the non-volatile residuum stays and cracks to heavy residue and coke in much the same way as it does in the engine. From this standpoint the Conradson test seems to us to measure, not the total carbon which the oil forms—this, after all, is a matter of no interest—but that formed by the non-volatile oil residuum remaining on the metal surfaces. From the agreement which we have found to exist between engine tests and Conradson tests, it appears that either all or a constant proportion of the carbon so formed remains adhering to the metal surfaces.

From these considerations it appears desirable to use an oil viscous enough to supply the necessary lubrication, but volatile enough to vaporize after it has reached the piston and cylinder-head surfaces, leaving the minimum of residue.

HEADLIGHT RESEARCH AT FRENCH LICK

Test Program Discussed and Results of Preliminary Study Demonstrated

The headlight research which is being carried out by the Illuminating Engineering Society and this Society made marked progress as a result of the series of meetings held during the Semi-Annual Meeting week at French Lick Springs, Ind. On Thursday morning, May 26, the Joint Steering Committee on Headlight Research of the two Societies met at breakfast with the car and lamp manufacturers who have purchased the equipment designed for the test work. The object of the meeting was to discuss a program of an investigation to be carried out by the test-equipment owners in an effort to get a consensus of opinion as to what type of light distribution provides adequate safety and reasonable comfort in driving. One preliminary test problem, sent out in advance to those interested in the research, served as a basis for the discussion.

In the evening, demonstrations were held in which members of the Committee explained the construction and operation of the test equipment to those interested in the actual carrying out of the research, and the results arrived at from the study of the preliminary problem were shown.

The Headlight Subcommittee on Distributions, representing the Joint Steering Committee on Headlight Research of this Society and the Illuminating Engineering Society, formulated

[3] See THE JOURNAL, June, 1926, p. 607.

the preliminary test problem and is charged with the development of the general test program. The members of this Subcommittee are: R. N. Falge (chairman), Dr. H. C. Dickinson, Harry Doane, W. R. Griswold, J. H. Hunt, W. M. Johnson, and T. J. Lítle, Jr. An indication of the aims of the demonstration at the Semi-Annual Meeting and its relation to the general headlight project may be gained from the announcement sent out by the Subcommittee to the car and lamp manufacturers that were expected to participate in it. The announcement, which includes a general statement of explanation and one specific preliminary problem, is printed below.

Announcement of Headlight Subcommittee on Distributions

The Joint Steering Committee on Headlight Research of the Illuminating Engineering Society and this Society at its last meeting in January reviewed the progress which had been made in furthering its program for investigating, in a careful and systematic manner under actual driving conditions, the road illumination requirements from automobile head-lamps. It developed that, while a satisfactory number of test equipments had been built and distributed, very few had been used to any great extent. It was generally agreed that the difficulty probably arose from the fact that many observers were somewhat at a loss to know just how or where to start. With this in mind, it was decided to prepare and distribute a series of specific problems covering particular beam characteristics rather than attempt to study the problem as a whole.

Data sheets were prepared and submitted by a Subcommittee appointed to develop a program along this line. The first problem, as given in the first paragraph on Data Sheet 1, is intended to determine intensity and width of beam at various distances ahead of the car. This data sheet also suggests an arrangement of test equipment with which to start, and outlines briefly the character of road needed to provide data of greatest value, the procedure for testing, and the disposition of reports. Data Sheet 2 gives detailed instructions on the initial test set-up. Blank copies of Data Sheets 2 and 3 are to be used in recording data. They should be filled in very carefully and completely.

Obviously no part of the beam can be separated for study without regard to the remainder. In specifying

Data Sheet I
I.E.S.-S.A.E. Headlighting Investigation

PROBLEM NO. 1.—Determine the minimum intensity and spread of light required at various distances ahead of a vehicle from the main beam from depressible-beam headlights to provide adequate safety and reasonable comfort under all ordinary conditions of driving.

ARRANGEMENT OF EQUIPMENT.—Place the car on a level floor with the head-lamp faces 25 ft. from the screen shown in Fig. 3 of Data Sheet No. 2. With the head-lamp door in place and all lenses and shields removed, turn the lower of the two focusing-screw heads on the rear of each head-lamp housing until the beam pattern on the screen is circular. If the beam is distorted sidewise, try reversing the bulb in the socket and changing bulbs. Then turn the upper focusing-screw until the beam pattern is of minimum diameter. Next, install the shields and the lenses with horizontal flutes and aim the beams as instructed in Fig. 3 of Sheet No. 2. Finally, install the lenses with vertical flutes and clamp all securely in place.

TEST ROADS.—To conserve the time and energy of both observers and members of the Committee whose duty it will be to analyze the data turned in, observations should be confined, so far as possible, to roads which have been selected by the observer as including the more difficult conditions to be met. Strange roads should, of course, be selected wherever possible. *Higher intensities* will be needed on the darker-colored roadbeds, particularly when wet. Occasional holes and inequalities in the roadbed, as well as deep ditches at the sides, require more light. *Wider spreads* are especially desirable in rounding curves where one side of the beam illuminates the roadbed.

SUGGESTED TEST-PROCEDURE.—To facilitate analyzing test data, it is requested that observers, so far as possible, standardize on speeds of 15, 25, 35 and 45 m.p.h. The *width* of the beams may be varied by using lenses with vertical flutes of different spread. Rheostats are provided for changing the *intensity* of light in the beams.

REPORTS.—Please fill in the data sheets accompanying the problems carefully. Forward them promptly to C. B. Veal, Research Manager, Society of Automotive Engineers, 29 West Thirty-ninth Street, New York City. The number of problems that can be handled in a given time will depend upon how promptly reports are turned in. Facts established by earlier studies will be used in limiting the number of variables in the problems that follow.

Data Sheet II
I.E.S.-S.A.E. Headlighting Investigation

Problem No....... Test No....... Test Date......

Sponsor company ....

Observer ....

Driver ....

Arrangement of Head-Lamps on Test Car

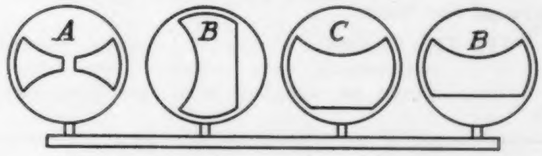


Fig. 1—Front View of Head-Lamp Assembly

Head-Lamp Number	4	3	2	1
Filament at Focus	Yes	Yes	Yes	Yes
Lens (Flutes Vertical)	10	32	15	10
Lens (Flutes Horizontal)	—	4	2	—
Current Through Filament[1]				

Fig. 2—Shields

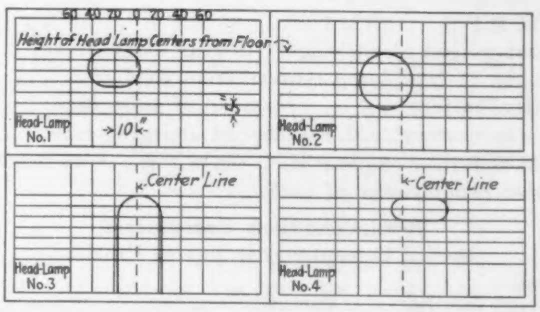


Fig. 3—Appearance of Beams on Screen at 25 Ft. Before Installing Lenses with Vertical Flutes. Center Screen by Sighting through Rear Window over Radiator-Cap[2]

[1] Measure current for individual lamps with others burning. If car battery is used, use special 5-volt bulbs and measure current with generator charging at contemplated speed. Weston Model 280, single range, 5-amp., 50-division ammeter recommended.

[2] Beams must be aimed with load in rear seat same as used in road test or proper allowance made.

a test set-up for a particular problem, the Subcommittee was obliged to make certain assumptions as to light distribution in parts of the beam not under investigation, and in this matter they followed the conventional distribution. Observers may, of course divert from this course at will. In doing so, however, they are asked to bear in mind that certain inherent limitations and restrictions cannot logcally be ignored.

The following factors serve to determine in a general way the intensities permitted or required at various points ahead of the car and roughly outline the shape of the beam.

(1) *The Quantity of Light Available.*—If all restrictions were removed few drivers would be satisfied with less than daylight conditions. Actually, the distribution of light ahead of the car is a series of compromises. Not only must the light be fully utilized, but, in shifting it from one part of the beam to another, the gain at the one point must be carefully weighed against the loss at the other. In studying a particular part of the beam the investigator therefore must limit his requirements to the minimum. The Subcommittee has asked that we provide only for "adequate safety and reasonable comfort" in driving. In other words, the proper setting is one where the driver can relax somewhat and still have sufficient light to meet any ordinary emergency. Results will vary, of course, with the skill, eyesight, strength, temperament and driving habits of the observers. The average of many observers should offset this variation

(2) *The Location of the Head-Lamps on a Vehicle.*—Maximum visibility of objects several hundred feet ahead obtains when the beams are aimed straight down the road. Unfortunately, such aiming is impracticable because the head-lamps are located almost directly in line with what an approaching driver needs most to see. The best compromise that can be effected between the desires of the driver, on the one hand, and those of other users of the highways, on the other, limits the intensity above the head-lamp level to only a fraction of what might be desired

This problem is further complicated by the fact that the beams are raised materially when the rear seat is loaded and in passing over hills and rough roads. Experience has indicated that to provide safe and satisfactory driving conditions with a single-beam head-lamp is practically impossible. For this reason the Subcommittee has assumed that the driver would have two beams under his control, one depressed more than the other for passing other cars. The first studies are directed to the main or upper beam. Auxiliary driving-lamps are provided for passing

(3) *The Depth of the Beam Below the Head-Lamp Level.*—This is limited by the distance ahead at which vision is obstructed by the front of the car

(4) *The Distribution of the Intensity in the Beam from Top to Bottom.*—This follows natural laws. The maximum intensity is provided at the top to reveal objects several hundred feet ahead. Too much light in the foreground interferes with vision beyond

(5) *Bright and Dark Streaks and Spots in the Beam.*—These are objectionable

(6) *Color of Light.*—Under normal atmospheric conditions white light is better than colored light. It is more efficient as ordinarily provided and objects are revealed in their true colors. Yellow light appears to have advantages in penetrating fog

(7) *Breadth at Beam.*—Some light is needed to illuminate roadsides, cross-roads and

(*Concluded on p.* 801)

Data Sheet—3
I.E.S.-S.A.E. Headlighting Investigation

Problem No....... Test No....... Test Date......

Sponsor company ....
Observer ....
Driver ....

Test Record

Make of car.................. Model...............
Odometer—Start................ Finish............
Contemplated speed[3]—
15 M.P.H... 25 M.P.H... 35 M.P.H... 45 M.P.H...
Total weight of passengers in rear seat.............
Height of head-lamp centers from road.............
Extra battery Number of cells used........
or car battery[4].......Full-load charging-rate
15 M.P.H... 25 M.P.H... 35 M.P.H... 45 M.P.H...
Rated candlepower of bulbs........................

Road Conditions Encountered
(Record Percentages in Spaces Provided)

Road—
Very familiar.... Partially familiar.... Strange....

Roadbed—
Width, ft.—14.... 16.... 18.... 20.... 22.... 24.... 26.... 30....
Material—Brick ..... Concrete ..... Asphalt ..... Gravel..... Unimproved.....
Color—Light..... Medium..... Dark.....
Condition—Smooth...... Rough...... Ruts...... Shoulders..... Dry..... Wet..... Snow.....
Character—Level...... Rolling...... Hilly...... Straight..... Curves..... Sharp Turns.....

Roadsides—Banks.... Ditches.... Grass.... Vegetation.... Trees.... Fences.... Poles....
Atmosphere—Clear .. Haze .. Fog .. Rain .. Snow ..
Extraneous Light—Dark .. Starlight .. Moonlight .. Street Lights .. Highway Lights ..
Traffic—None... Light... Medium... Heavy...
Cross Traffic—None... Light... Medium... Heavy...
Warning Signs—Good... Fair... Poor... None...
Unexpected Obstacles—Pedestrians.... Animals.... Horse-Drawn Vehicles... Bicycles... Bridges... Road Repairs.... Overhanging Obstructions.... Cars Parked on Pavement.....

Comments:
Which of the above items were most influential in arriving at the light distribution finally determined upon?

[3] Contemplated speed is the speed driver endeavors to maintain during test.

[4] Separate 8-volt battery preferred. If *car battery* is used, adjust charging rate to keep battery fully charged at all times, but not so high as to require water oftener than once in 2 weeks. For tests using car battery, secure special bulbs from S. A. E. Headquarters.

Assembling Contest Proves Spectacular

Technical Sessions Very Well Attended
Twenty-Two Papers Presented

WITH an attendance of approximately 800 and with a flood, a narrowly averted railroad disaster and a nearby tornado, the 1927 Summer Meeting will go down in S.A.E. history as one of the most exciting meetings ever held.

Although a large part of the lower golf course and the town of French Lick Springs were flooded and thunder-storms rolled in from the West at least once a day, it was not necessary to give up any of the scheduled events.

The technical sessions were well attended. The complete news account of the sessions starts on p. 803. The report of the chassis-assembling contest and the various sports, together with the photographs of the events taken this year by Underwood & Underwood, appear on the following pages.

Comprehensive reports of the technical sessions and sports events were published day by day in many of the daily newspapers in automobile centers, several of which sent members of their staff to "cover" the meeting. The *Indianapolis News* was represented, its automobile editor, William Stokes, who, in addition to keeping stories running over the wires between French Lick Springs and Indianapolis, rushed the first picture made of the chassis-assembling contest to his paper.

TRAIN DISASTER NARROWLY AVERTED

S. A. E. Special Stopped Within 20 Ft. of Washout in 50-Ft. Embankment

Members of the Society bound for Cleveland, Detroit and New York City on the special train which left French Lick Springs on Saturday afternoon at 5.45 had a narrow escape from possible death or injury when the train was flagged by two men a short distance from a washout near West Baden resulting from the torrential rains that caused the flooding of almost the entire lower part of Indiana. The embankment was approximately 50 ft. high and had it not been for the judgment and decisive action of the men in flagging the train and the emergency stop made by the engineer, it is probable that the engine and one or more of the cars would have gone over the embankment. The train returned to French Lick Springs for 5½ hr. during which time 20 carloads of fill was dumped to replace the washed-out roadbed.

In recognition of the service performed by the men flagging the train and the engine crew, the Society members on the train contributed to a fund to reward them.

As the S. A. E. special train reached Indianapolis too late for the two New York cars to be attached to any of the regular trains, they were routed as far as Pittsburgh as a special train, dining car service being provided between Columbus and Pittsburgh, at which latter point the two cars were attached to a regular New York train.

Lower Indiana Flooded

The continued torrents of rain which had fallen for some part of every day for the last few weeks had swollen the White River to such an extent that thousands of acres of farm lands had been inundated. This condition extended to French Lick Springs, as Lost River, after a particularly heavy downpour on Wednesday, May 25, broke through its levee at West Baden and, with the overflow from Lick Creek, flooded the lower golf course to within a few feet of the clubhouse and overflowed the tennis courts to a depth of 2 ft. The photographs on p. 805 of the first and eighteenth fairway on the lower golf course, illustrate some of the damage.

Members of the Society driving to French Lick Springs found road conditions extremely severe in many cases, the floods necessitating extensive detours. This was one of the difficulties encountered by the *Daily SAE* staff in rushing photographs and cuts to and from Louisville, a distance of 60 miles.

After planning to use the lower golf course as a landing field on his flight from Indianapolis, T. J. Lítle, Jr. was forced to fly to the Municipal Landing Field at Louisville, the only available places at French Lick Springs being entirely under water. One of several photographs Mr. Lítle took on his flight is reproduced in the following pages.

In spite of the fact that it rained during some part of every day, it was unnecessary to make any change in the program of the sports events, the storms never breaking before 5 o'clock on any of the 4 days of the meeting.

MOTION PICTURES TAKEN

As several of the members attending the Summer Meeting were equipped with the 16-mm. motion-picture cameras, arrangements were made with them by the Meetings Com-

mittee for an extra print of all pictures taken to be sent to the Society for the purpose of making up a complete motion-picture reel of the chassis-assembling contest and the various sports which have become such an important part of S.A.E. Summer Meetings. This picture will carry adequate titles and explanations so that it will tell the complete outdoor story of the meeting. Arrangements will be made for exhibition of the film by each Section at one of its meetings held in the early autumn.

CHASSIS-ASSEMBLING CONTEST A SURPRISE

Washington Section Team Shows Practical Ability by Winning in 10 Min., 22 Sec.

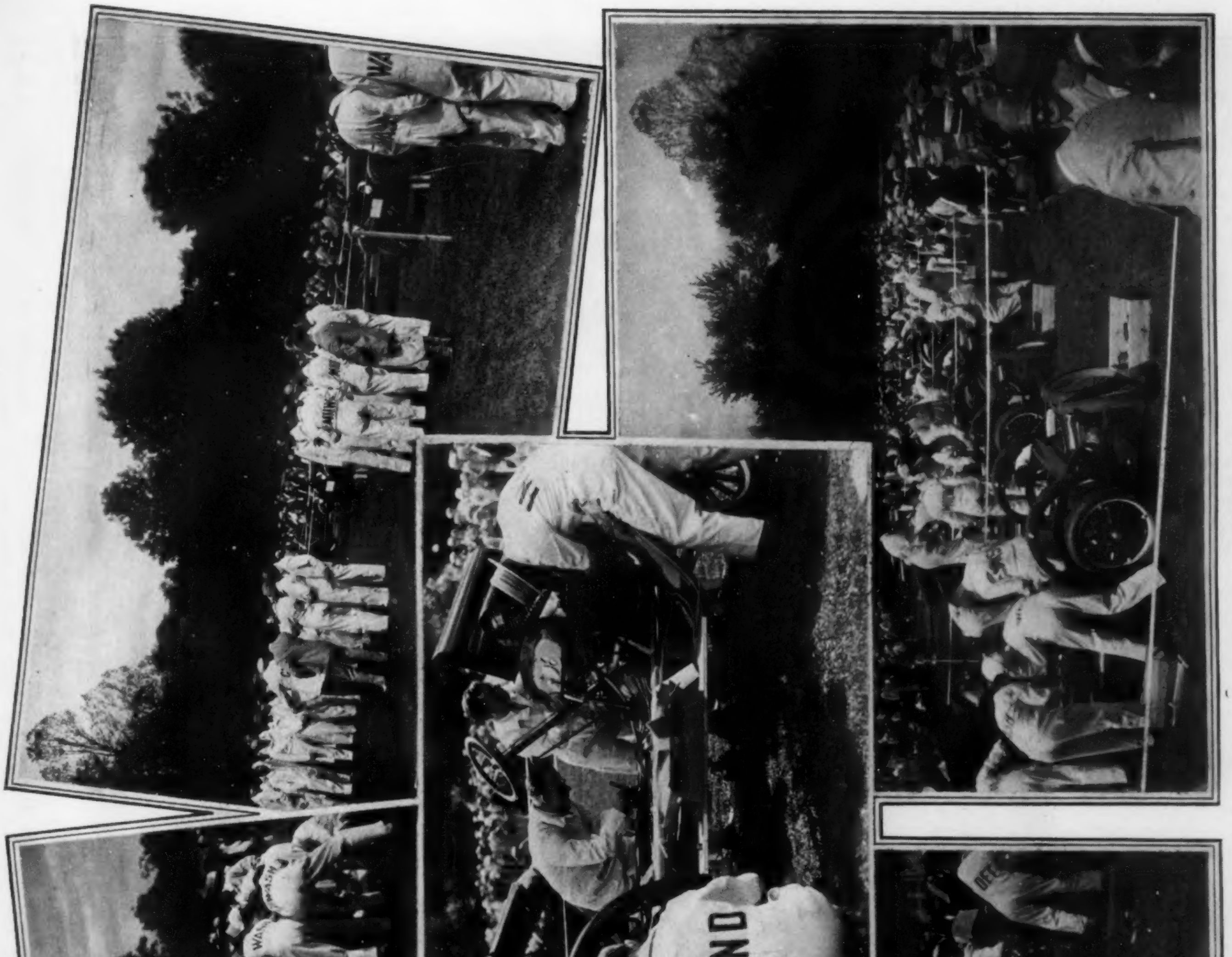
Under cloudless skies and cheered on by one of the largest galleries that ever witnessed an S.A.E. stunt, the novel chassis-assembling contest was run off on Thursday, May 26. The Washington Section team, like the proverbial dark horse, provided the afternoon's surprise by passing the judges' stand on the final lap in 10 min. 22 sec. after the first wrench was picked up.

The success of the contest was due largely to the careful preparations made, for which Alden Dinsmore of the Chevrolet Motor Co. was responsible. Two o'clock on Thursday afternoon found the chassis lined up in their respective pits, with the parts that had been removed from each chassis placed in wooden trays at the back of each chassis, with the exception of the larger parts, such as wheels, which stood up against the chassis. Each chassis had been carefully checked to make sure that all were in exactly the same condition, and guards were stationed to prevent anyone from approaching near the chassis.

The condition of the cars at the beginning of the contest was as follows: One front and one rear wheel was removed and the rims demounted; the carbureter was removed, the feed valve of the vacuum tank closed and the tubing from the vacuum tank to the carbureter removed; the gasoline tank was emptied and dismounted; the suction line on the intake manifold was disconnected; the spark-plugs were removed and the wires connecting the spark-plugs and the distributor head were taken out, the timing not being announced either before or during the contest; the center distributor wire was also removed as well as the distributor head and rotor; the battery was removed; the radiator was emptied and the drain-plug left open; the steering connecting-rod was disconnected at one end. The gasoline and water for the cars was

THE TEAM THAT WON THE CHASSIS-ASSEMBLING CONTEST

Upper View Shows W. H. Ragsdale Driving Out the Washington Section Chassis and the Lower Left View Shows Him Being Flagged at the Finish by President Hunt, Who Acted as Judge. The Complete Team Appears at the Lower Right



EXCITING MOMENTS DURING THE CHASSIS-ASSEMBLING CONTEST

FIVE MINUTES AFTER THE START OF THE CHASSIS-ASSEMBLING CONTEST

Harry Horning Appears Astride the Milwaukee Section-Chassis Where He Directed Activities and Paul Geyser Appears in the Pit of the Chicago Section Team in the Only Part of the Size 42 Coveralls That Fitted His Size 50 Physique

in unlabeled 2-gal. cans placed 150 ft. from the cars, the distinction as to water and gasoline being left to the inspector on each team.

No more interesting account of the contest can be given than that printed in the *Daily SAE* of May 27, as follows:

The Washington Section team, including several deft-handed trouble-shooters from the Bureau of Standards, showed the way yesterday to the six other teams competing in the chassis-assembling contest.

The Washingtonians got their Chevrolet ½-ton truck all put together in the remarkable time of 6½ min., after which W. H. Ragsdale piloted it five times around the loop of roadway in front of the hotel. J. H. Hunt, S.A.E. President and one of the judges, gave Ragsdale the checkered flag just 10 min. and 22.6 sec. after the starting bomb had sent the teams leaping to their tasks.

Winners Given Bags

Besides a gorgeous silver cup which goes to the Washington Section team, the individual members each received a handsome Gladstone bag. The Cleveland team put their car past the judges in 12 min. and 54 sec. The order in which the others finished was: third, Detroit; fourth, Metropolitan; fifth, Chicago; sixth Milwaukee; and seventh, Indiana.

The personnel of the winning Washington team included: John O. Eisinger, captain; Dr. H. C. Dickinson; W. H. Ragsdale; H. H. Allen; D. B. Brooks; G. A. Burn; Dalton Risley, Jr.; and D. P. Barnard, 4th. The first three named are members of the Bureau of Standards.

The chassis-assembling contest, the most successful stunt in the illustrious history of the S.A.E. meetings, drew a huge gallery. The event combined all the interesting features of a free-for-all fight and an automobile race together with some of the lighter touches of that famous one-reel comedy film of the old Biograph days, "Fun in a Nut Factory."

His Trousers "Disassembled"

Paul H. Geyser, of the Chicago Section, created a ripple of excitement just before the starting bomb when he discovered that the trousers of his white jumper were entirely inadequate. He got part way in and realized his mistake so late that it required the combined efforts of his team mates to extract him. They broke the suit in two and Paul emerged like a ruffled caterpillar from a heavy-duty cocoon. During the contest he wore the pants astride his bosom as an apron.

The Cleveland Section started their engine first and attempted to drive away without their right rear wheel. The fact that the car would not go drew this omission to their attention. By the time they had the wheel on Washington was away in a cloud of dust. Harry Horning stood amidships on the Milwaukee car paging each of his men in turn with the query: "Hey! Where in hell does this go?" "This," it developed, was a nut which was observed still in Harry's possession some time after the contest ended. Despite the missing nut, the Milwaukee car ran so enthusiastically that the entire team was required to stop the engine after the race.

Indiana Car Crashes

The Detroit team not only had a loose distributor screw but also lost its screwdriver. W. R. Strickland, the Detroit driver, decided to try it anyway on two cylinders. He finished—eventually. Indiana, which did not get started until after the others had finished, added a real race flavor to the event by bucking into a parked car.

On behalf of the Washington team, Mr. Eisinger has made formal denial of charges by several of the also-rans that his crew confused their opponents by tossing spare parts from the Washington car into the adjoining pits. Also, he declares, his men positively do not know who turned off the gasoline tank pet-cock on the Indiana car.

Because he is married and has a family the *Daily SAE* declines to reveal the identity of the neighborly individual who got into the wrong pit and helped the fellows next door get their car started.

The service men who spent 4 hr. reconditioning the chassis after the contest probably indulged in some caustic comments on the mechanical ability of designing engineers. They also enjoyed their ride through the water to obtain a new front-wheel bearing to replace the one that appeared to have passed through a coffee grinder, all due to the belief on someone's part that the inner race of the bearing was an extraneous part put in a front wheel merely to make it appear complicated.

The "air-cooled" car was favored by one team which decided to leave out the water. It is possible that they anticipated that their smoking engine would throw a smoke-screen sufficient to completely baffle their adversaries.

And last, but not least, the complete ignoring of that unnecessary factor known as the firing order made the "track" sound like the battle of Flanders. It has always been believed that there was some definite order of connection between the distributor head and the spark-plugs, but a review of the various crossed wires at the close of the race did not bear this out.

The year 1928 should see some radical changes as the result of the chassis-assembly contest providing the engineers' own work is put into practice.

A. W. ANDERSON WINS GOLF CROWN

Low-Qualifying-Score Prize Won by Bryant Bannister Who Tied with Sanford Brown

The ever increasing interest in golf as the major sport of the S.A.E. Summer Meetings was indicated again this year by the large number of members who swarmed over both of the French Lick Springs Hotel courses. The heavy rains plus the breaking of a levee on Lost River and Lick Creek flooded six holes on the lower course to a depth of 2 ft. or more, making this course unavailable on Friday and Saturday.

Displaying championship form throughout the match, A. W. Anderson, of the Borg & Beck Co., and a well-known golfer, walked off with the 1927 Golf Championship prize by defeating J. B. Shea, of the Firestone Tire & Rubber Co., Chicago.

Anderson's card contained several birdies with the result that at the end of the 12 holes he was running 1 above par, defeating Shea 7 up and 6 to go.

The prize for the low qualifying score was captured by Bryant Bannister, who tied Sanford Brown with an 82. The award was decided by the toss of a coin and Bannister won.

Besides the championship flight, those qualifying were divided into four flights and the prizes were won as follows:

FLIGHT A

L. V. Cram—5-3-5-4-5-4-7-5-4, out 42; 6-4-5-4-5-6-4-6-5, in 45; total 87

M. H. Cox—7-4-6-4-4-4-6-5-5, out 45; 4-3-5-6-6-6-4-4-5, in 43; total 88

FLIGHT B

M. R. Wolfard—6-4-4-5-6-4-7-7-4, out 47; 5-5-4-4-6-5-4-5-5, in 43; total 90

R. E. Clingan—6-7-5-4-5-5-5-5-6, out 48; 6-4-6-4-6-5-4-4-6, in 45; total 93

FLIGHT C

J. B. Funk—8-7-5-3-5-4-7-5-4, out 48; 5-4-4-4-6-5-5-6-6, in 45; total 93

Gus Ek—4-7-6-6-6-5-6-5-5, out 50; 4-4-6-3-6-6-6-5-4, in 44; total 94

FLIGHT D

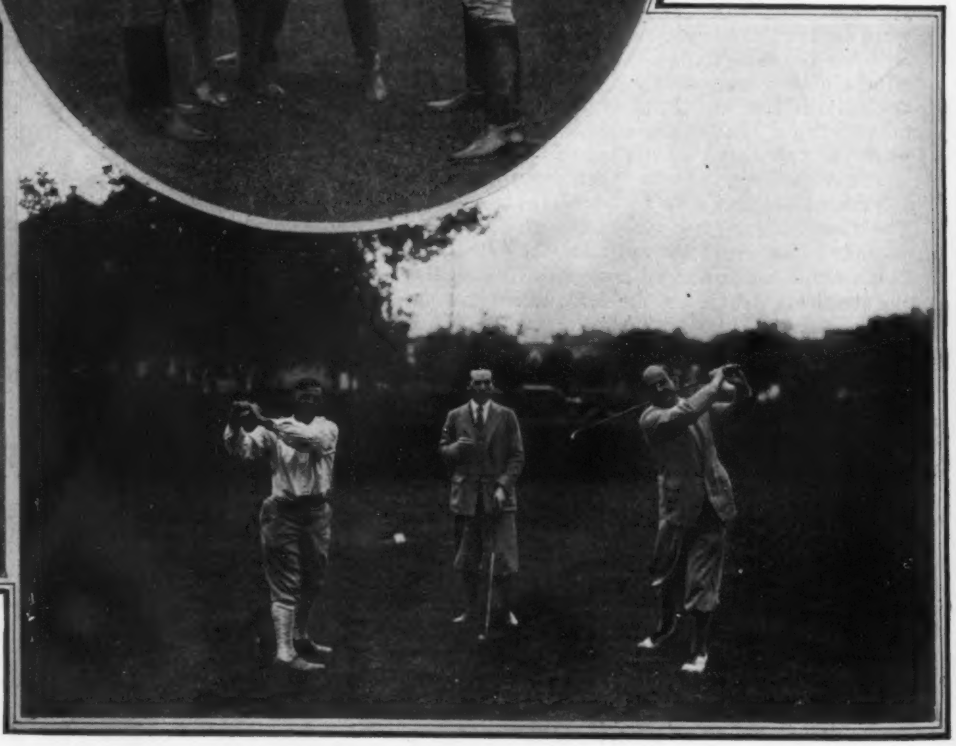
Gordon Spice—7-5-5-5-6-4-7-5-5, out 49; 5-4-6-4-7-5-6-7-7; in 51; total 100

F. E. Booth—6-5-9-4-4-5-4-7-4, out 48; 6-4-6-6-9-7-4-6-5, in 53; total 101

FLIGHT A

L. V. Cram, 87; M. H. Cox, 88; G. A. Young, 90; G. H. Brown, 94; H. C. Tillotson, 95; J. W. White, 98

J. H. McDuffee (Above) Served as Chairman of the Golf Committee. The View at the Left Shows the Tribulations of a Golf Champion



1927 S.A.E. GOLF CHAMPIONS AND THE GOLF COMMITTEE

A. W. Anderson, Winner of the Championship Flight, Appears at Lower Left. The Winner of the Class A Flight, L. V. Cram, Appears at Left of Group in the Lower Right Photograph with Stanley Whitworth and M. H. Cox, Runner-Up. Mrs. Stanley Whitworth, Winner of the Ladies' Golf Championship, Appears at the Upper Left, with Sandford Brown and Bryant Bannister, Who Tied for the Low Qualifying Score, on Her Right and R. H. DeMott and F. W. Marschner, Members of the Golf Committee, to Her Left

SOME OF THE SPRINTS AND J. W. TIERNEY, WINNER OF THE 50-YD. DASH

Dazzling Speed Developed by S.A.E. Athletes in Potato Race (Upper Left). Fatman's Race, Showing Manner in Which Guy Motz Made His Last 5 Yd. (Upper Right). Shorty McMillan and Olney Jones Winning the Three-Legged Race (Lower Left), and Janet Rockwell Walking Away from the Field in the 50-Yd. Dash for Ladies (Lower Right)

FLIGHT B

M. R. Wolfard, 90; R. E. Clingan, 93; George H. Hunt, 98; J. T. Kennedy, 100; J. F. Winchester, 103

FLIGHT C

J. B. Funk, 93; G. A. Ek, 94; R. H. DeMott, 100; C. F. Clarkson, 102; L. M. Clegg, 103

FLIGHT D

Gordon Spice, 100; F. E. Booth, 101; L. R. Buckendale, 102; L. G. Hewins, 109; H. E. Adams, 110

Submarine Golf Played by the Ladies

Amphibious women golfers swam, walked, waded, and dove through a sea of mud and water in the hopes of annexing the 1927 S.A.E. Ladies' Golf Championship. That no contestants were drowned is due solely to the charity of the Golf Committee who decided to count 5 for each player on each of the six holes submerged. The difficult circumstances under which the matches were played made brilliant playing an impossibility and great praise is due the golfers for their scores under such unusual conditions.

Mrs. Stanley Whitworth carried off the championship honors for 1927 with a score of 92, defeating Mrs. J. R. Jones, who took second place with a score of 98. No score by holes is given as some confusion might arise as to the nature of the strokes, whether golf or swimming.

The ladies' putting contest, which was held on the small nine-hole practice course.

THE ANNUAL S.A.E. FIELD DAY

"Shorty" McMillan Fails to Win 50-Yd. Dash the Sixth Consecutive Time

When the levees crumbled on No. 1 hole on the lower golf course and everything but the hotel floated down the White River, the Sports Committee lost no time in preparing a new field for the events. The only ground that could be found that was high enough not to be mushy under foot was in front of the Pluto Water Bottling Works. The accompanying birdseye photograph was not taken by T. J. Litle on his no-place-to-land flight, but from the fifth-story window of the bottling works.

Ex-Navy men were in big demand as it took some real fancy diving to retrieve the jumping standards and other athletic gear from the flooded area. F. G. Whittington, upon receipt of a radio from Mayor Will Rogers, took charge of the flood relief work and reported that Vic Kliesrath was peeved at the change in fields because he had the Baby Shadow all tuned for the 50-yd. dash.

"Shorty" McMillan, winner of the 50-yd. dash for 5 consecutive years, in order to save himself for the final did not cut in his supercharger until the halfway mark, and then his differential gave way as the man from the Windy City, J. W. Tierney, broke the tape. It is rumored that "Shorty" has already started training for a come-back next year.

From the standpoint of the gallery the fatman's race was the best of all the events. Although it was announced that Les Carroll won the race, only the judges saw him do it, as all eyes were watching the sylph-like Guy Motz make the distance as follows: 20 yd. on his feet, 15 yd. on his chin, 10 yd. on his chest and 5 yd. on his what have you.

The long and short of the three-legged race is that none of the partners matched at all, but they made the 50 yd. in about 8 jumps and 40 stumbles. Olney Jones and "Shorty" McMillan fell in first; Tierney and Coleman, the Chester County Quaker, rolled in second; and the show money was taken by Ben Blair, the Cleveland speed king, and Les Carroll. J. O. Eisinger, who won the potato race, claimed he could have made a lot better time in this race if the potatoes had been matched. J. W. Tierney could have done better than second place had he been on K. P. duty and paring the potatoes instead of running with them. As a member of the Ku Klux Klan, Coleman was unable to get the O'Brien potatoes in any better than third.

The winners of the track and field events were as given in the following summary:

50-Yd. Dash (Men)—First, J. W. Tierney; second, G. T. Moore; third, W. E. England

50-Yd. Dash (Ladies)—First, Miss Janet Rockwell; second, Miss Katherine Rockwell; third, Mrs. H. L. Towle

Fat Man's Race—First, Lester Carroll; second, W. F. Rockwell; third, L. G. Hewins

Three-Legged Race—First, Olney Jones and "Shorty" McMillan; second, J. W. Tierney and H. B. Coleman; third, Lester Carroll and B. H. Blair

Potato Race (Men)—First, J. O. Eisinger; second, J. W. Tierney; third, H. B. Coleman

Potato Race (Ladies)—First, Miss Janet Rockwell; second, Miss Virginia Geyser; third, Mrs. W. W. Pennington

Bean Race (Ladies)—First, Miss Janet Rockwell; second, Mrs. Paul Roche; third, Mrs. W. W. Pennington

Egg Race (Ladies)—First, Mrs. Paul Roche; second, Mrs. F. A. Cornell

Needle and Thread Race (Ladies)—First, Miss Virginia Geyser; second, Mrs. J. T. Greenlee; third, Mrs. Paul Roche

Inter-Section Relay Race—First, Detroit; second, Milwaukee; third, Chicago

Shot Put—First, B. H. Blair; second, Ray Kauffman; third, E. Botts

Standing Broad Jump (Men under 40)—First, C. F. Raun; second, G. T. Moore; third, B. W. Brodt

Standing Broad Jump (Men over 40)—First, F. G. Whittington; second, J. C. Talcott; third, Ray Kauffman

High Jump—First, Ralph Baggaley, Jr.; second, J. C. Talcott; third, B. W. Brodt

Throwing Baseball (Ladies)—First, Mrs. Alice Mills; second, Miss Elizabeth Walthers; third, Mrs. G. T. Greenlee

CHICAGO SECTION SPRINGS SURPRISE

Wins Inter-Section Athletic Championship with a Score of 71½ Points

The present Inter-Section Championship cup was won in 1925 by the Metropolitan Section and in 1926 by the Detroit Section. As the previous Inter-Section Championship cup had been won three times by the Metropolitan Section and so became its permanent trophy, it was expected that the Metropolitan and Detroit Sections would be fighting for first place this year, but to the surprise of everybody the Chicago Section won over the two larger sections of the Society with a total of 71½ points as against 58 and 49 points respectively for the Detroit and Metropolitan Sections. The high score of the Chicago Section was due to the winning of the golf tournament by A. W. Anderson; the winning of the Horseshoe Pitching Contest, both singles and doubles, by J. T. Greenlee and W. H. Schulz, and by the speedy work of the Chicago athletes in the track events. F. G. Whittington, as Chairman of the Sports Committee, also contributed to the high score of the Chicago Section by winning the standing broad jump.

The Inter-Section Championship cup does not become the permanent property of any one Section until won three times by one Section. As the Milwaukee Section rolled up a total of 32 points in the track and field events, and five of the other Sections totaled 60 points, it is predicted that it will be a difficult task for any one Section to obtain permanent possession of the cup for several years.

FLOOD HAMPERS TENNIS FINALS

Nikonow Wins Championship—Players Use Grass Court Laid Out in Emergency

The 1927 Tennis Championships were played under unusual conditions owing to the flood. After the preliminary match had been played, heavy rains left the courts under water which necessitated the hasty laying out of a grass court that was used for some of the matches.

The 1927 S.A.E. Tennis Singles Championship Crown is worn this year by a new champion, J. P. Nikonow, who defeated B. J. Lemon in the finals, in straight sets, 6-2, 6-1.

The doubles championship was won by N. G. Shidle and J. P. Nikonow from D. S. Cole and C. T. Klug in straight sets, 6-2, 6-4.

Players were handicapped according to United States Lawn Tennis Association rating.

The following summary gives the results up to the final round:

SINGLES CHAMPIONSHIP

First Round—C. L. Drake defeated Ralph Baggaley, Jr., 7-5, 6-1; W. S. Hadaway defeated Norman G. Shidle, by default; B. J. Lemon defeated R. F. Davis, 6-0, 6-2; C. T. Klug defeated Howard Ketcham, 6-1, 6-4; J. P. Nikonow defeated D. S. Cole, 6-4, 6-3; T. N. Bourke defeated Leo I. Gibbons by default

Second Round—W. S. Hadaway defeated C. L. Drake by default; B. J. Lemon defeated C. T. Klug, 6-0, 6-2; J. P. Nikonow defeated T. N. Bourke, 6-2, 6-4

Semi-Final Round—B. J. Lemon defeated W. S. Hadaway by default

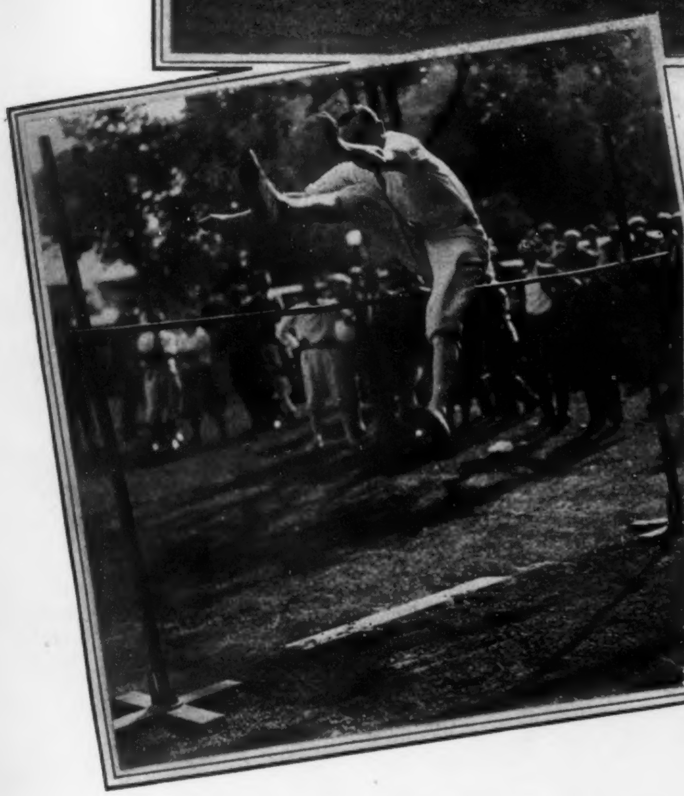
Final Round—J. P. Nikonow defeated B. J. Lemon 6-2, 6-1

DOUBLES CHAMPIONSHIP

First Round—D. S. Cole and C. T. Klug defeated Leo I. Gibbons and R. F. Davis 6-0, 6-2; C. L. Drake and Howard Ketcham carried through to final round for lack of opponent; Norman G. Shidle and J. P. Nikonow defeated T. N. Bourke and Mr. Johnson 6-4, 6-4

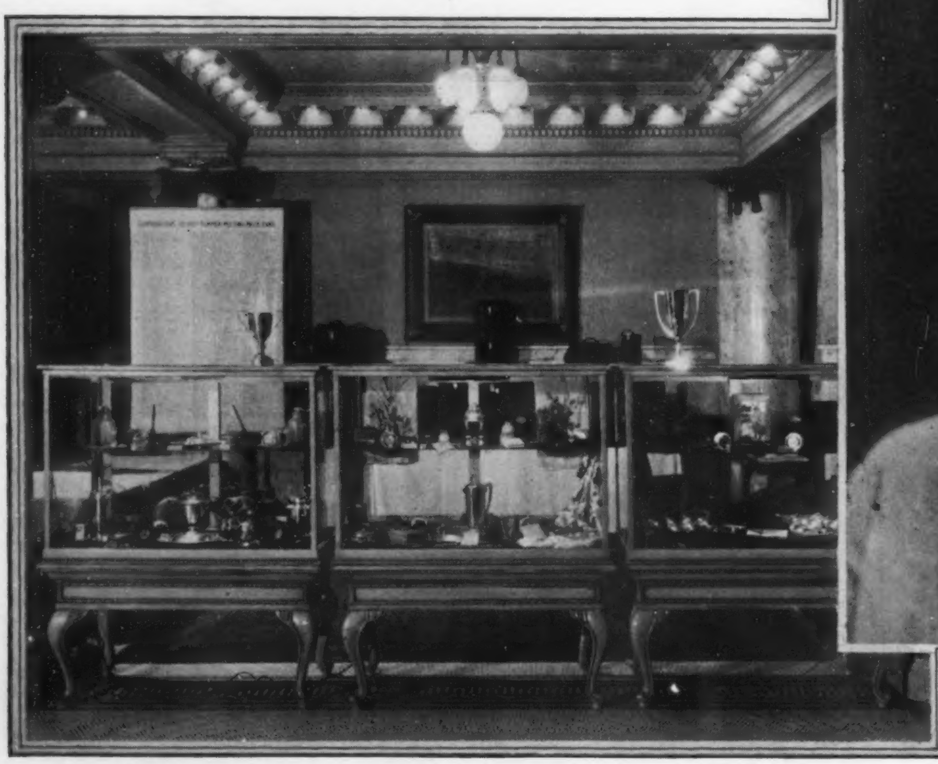
Final Round—Norman G. Shidle and J. P. Nikonow defeated C. L. Drake and Howard Ketcham 6-0, 6-2; Norman G. Shidle and J. P. Nikonow defeated D. S. Cole and C. T. Klug 6-2, 6-4

While the Tennis Committee was very successful in organizing and running off the tournament this year, some of the members interested have suggested that steps be taken some time prior to the 1928 Summer Meeting to incite a still greater interest in the Tennis Championship Tourna-



BIRDSEYE VIEW OF THE S.A.E. ANNUAL FIELD DAY AND TWO OF THE WINNERS

Photograph Taken from Top Story of the Pluto Water Bottling Works Shows the Temporary Grass Court Used for Tennis Finals After Water Flooded the Regular Tennis Courts. Ralph Baggaley, Jr., Winner of the High Jump, and J. P. Nikonow, Winner of the Tennis Singles



THOSE RESPONSIBLE FOR THE SPORTS PROGRAM

F. G. Whittington, Chairman of the Sports Committee (Lower Right), A. W. S. Herrington, Chairman of the Chassis-Assembly Committee (Upper Left), the Ladies' Entertainment Committee and the Display of Prizes at the S.A.E. Registration Desk. Reading from Left to Right the Ladies Are Mrs. C. T. Klug, Mrs. R. H. DeMott, Mrs. J. E. Reid, Mrs. A. W. S. Herrington, Mrs. J. F. Winchester, and Mrs. C. E. Heywood. Fred Cornell Was Drafted Because of His Expert Knowledge of Archery

VIEWS OF THE LADIES TREASURE HUNT

Over 100 Ladies Started Out To Hunt for **Captain Kidd's Treasure** (Lower Right), the First Clue Leading to One of the Pluto Water Springs (Center). The End of the Hunt (Upper Left) Resulted in Capt. Eddie Rickenbacker Giving the Prize to Mrs. W. W. Pennington (Upper Right). Walter C. Keys (Lower Left) Was Unable To Act as Chairman of the Treasure Hunt Committee Because of His Election as Chairman of the Annual Nominating Committee

ment. It is probable that some action may be taken by mail in an endeavor to increase the number of contestants for next year's games.

No Balls Used in Ladies' Tennis Finals

Owing to the inability of the contestants to see the marking lines through a foot of muddy water, the ladies' tennis-singles final match was switched to a game of "heads I win."

Only four entrants started in the tournament, Mrs. R. H. DeMott defeating Mrs. C. T. Klug, while Mrs. J. D. Cutter took Mrs. D. S. Cole into camp. The final play-off scheduled for Saturday morning did not materialize, but by mutual consent a coin was tossed, the somewhat hollow victory going to Mrs. DeMott, leaving Mrs. Cutter the second prize.

LADIES' EVENTS WELL PATRONIZED

Treasure Hunt, Bridge and Archery Claim Attention of Feminine Contingent

A contest of wits that appealed keenly to the women guests of the Society at the Summer Meeting was the treasure hunt. At 10:30 on Thursday morning, 125 of the 200 ladies in attendance eagerly tore open the envelopes that held copies of the first clue in the search that took them over the beautifully laid out French Lick Springs Hotel grounds and gardens, which were brilliantly displayed in the clear sunshine of what was termed by Hoosier patriots a typical Indiana day. Mrs. W. W. Pennington won the prize, a tan-leather suitcase.

The first port of call was one of the spring houses, mystically referred to in a clever jingle. The second stopping place for the treasure-seeking convoy was indicated by the hint "Go to the ladies' stepping-off place," and was in plain unequivocable English the block from which the horses are mounted. "Where love is spoken" took the sentimental to the shady lawns and quiet nooks in the garden, but the shrewd picked up the trail at the tennis courts. "Time hangs heavy," in a resort where every spot is rendered delightful either by charming views or stimulating sport, could refer to only one thing, the clock. The particular clock referred to was that over the registration desk, which bore the sign, "Where tears and smiles mingle." By this clue the railroad depot was indicated.

On the door of the railroad depot appeared a sign that presented a distinct choice to the seekers. It read, "They stood on the . . . at midnight." A bridge, certainly, but which bridge? was the question. Many naturally steered their course to the ornamental bridge in the Japanese gardens, but the good guessers found the next clue on the span over a stream in the miniature putting course. Among the luxuriant growth of flowers and shrubs on the banks of the waterfalls in the Japanese gardens was found the final clue, a direction from the master treasure-seeker of all time, Captain Kidd, to call for the prize at the S.A.E. headquarters.

Eighty women participated in the three bridge sessions, Friday morning at 10:30, Friday afternoon at 4:00 and Saturday morning at 10:30. Those placing first, second and third in the three sessions were: Friday morning, Mrs. T. L. Fawick, 1783; Mrs. A. Davidson, 1677; Mrs. R. J. Emmert, 1640; Friday afternoon, Mrs. C. M. Kaltwasser, 1825; Mrs. J. E. Reid, 1729; Mrs. B. M. Smarr, 1725, and Saturday morning, Mrs. C. T. Klug, 1842; Mrs. M. H. Cox, 1805; and Mrs. Paul Roche, 1708. Special prizes were given for the three highest scores attained during the week, which went to Mrs. Klug, Mrs. Kaltwasser and Mrs. Cox.

Diana had a number of rivals at French Lick Springs in the many contestants who turned out for the archery contest. Mrs. W. L. McGrath emphatically controverted the saying, "He who can, does; he who can't, teaches," by both doing and teaching. After instructing in the preliminary days of shooting, she herself entered the contest and won with a score of 23. Others who played were Mrs. Paul Roche, 20; and Mrs. J. H. Hunt, 16.

CLAY PIGEON FATALITIES HIGH

W. H. Miller Makes High Score by Breaking 50 Out of a Possible 50

A large number of members turned out for the trapshooting contests arranged by the Trapshooting Committee under the leadership of O. C. Lang. Many experts were developed, some of whom were discovered to have National reputations as crack shots. R. S. Ellis, of Philadelphia, was 1923 handicap champion of the State of New Jersey. W. H. Miller, of Cleveland, this year broke 98 out of 100, finishing fifth in the open tournament held each year at Pinehurst, N. C., where some of the best shots of the United States participated. O. L. Harrison in a recent shoot at Chicago won a team race by breaking all of the last 50 targets.

O. C. Lang and R. S. Ellis proved not only that they are real trapshooters, but that they can direct an event of this character to the satisfaction of all concerned.

A. J. MacDowel, who is just Mac to S. A. E. blunderbus experts, carried out the program of the Committee without the loss of a single man.

On Wednesday, the first day of the shoots, W. H. Miller made a perfect score, breaking 50 targets and winning the high net trophy. W. L. Kaiser scored 35, which with 15 added, won the high gross trophy. Mrs. L. A. Chaminade came out on the first day and shattered a goodly number of the birds, proving that she not only has a good eye but can handle a shotgun ably.

On the second day there were 21 entries. D. M. Pierson won the main event, scoring 39, his handicap giving him a perfect score. In the quail event O. C. Lang, in a shoot-off with Vic Kliesrath, won the net trophy.

In the championship on Friday Vic Kliesrath became the 1927 S. A. E. trapshooting champion. The runner-up was O. L. Harrison, scoring 44 out of 50. Arthur Davidson, in a shoot-off with W. L. Kaiser, won the high gross trophy, thereby being crowned the 1927 added bird champion.

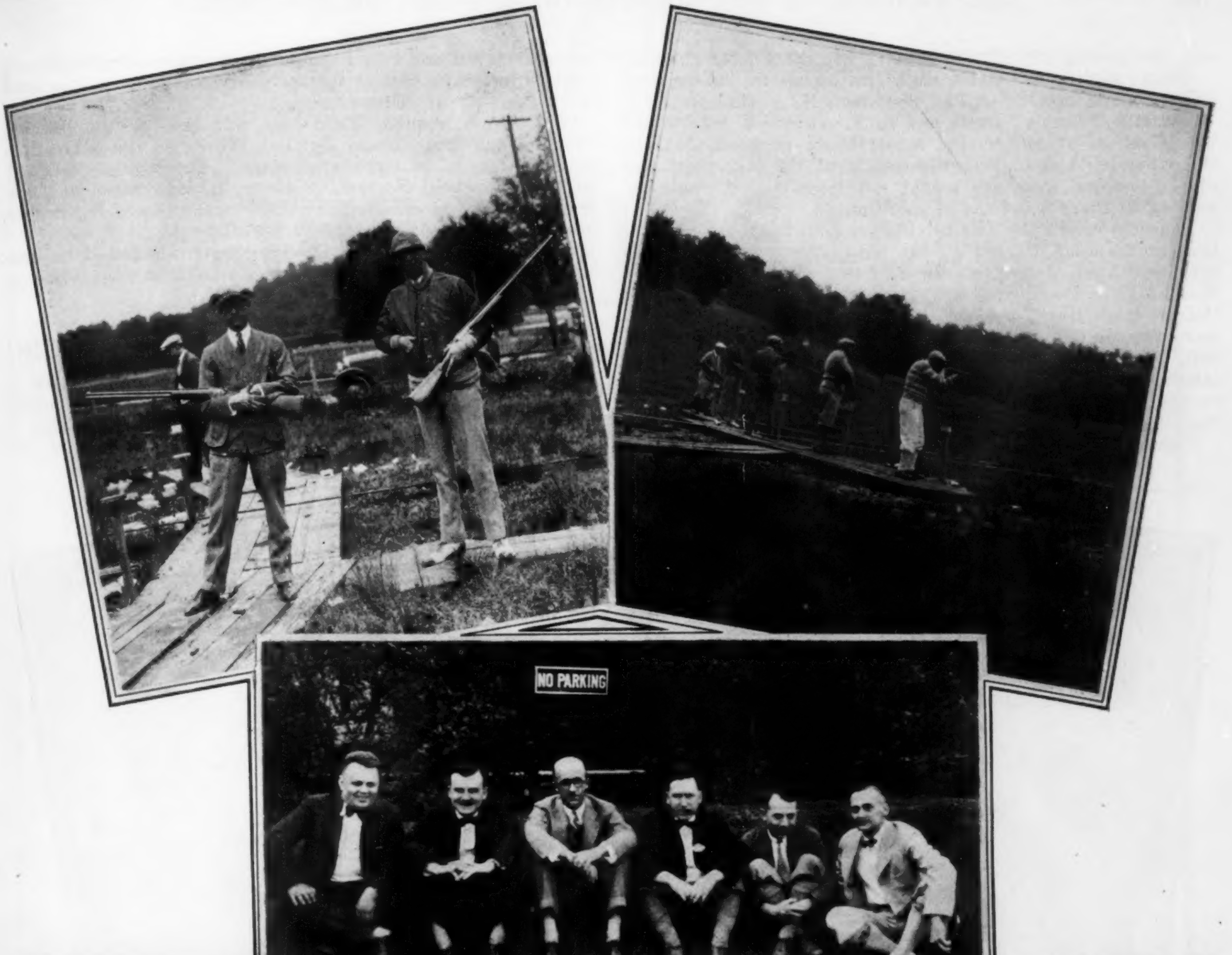
HORSES HORSES HORSES

How any automotive men could have learned as much about the wrong end of a horse as W. H. Schulz and J. T. Greenlee is past understanding, but they dropped the shoes so consistently against the pin that the orchestra in the hotel struck up Horses Horses Horses. In the doubles they took first place and in the singles Greenlee took first, and Schulz second. The final scores were 21-10, 22-6.

MANY STUNTS PULLED BY THE SECTIONS

As is always the case at the Summer Meetings, several of the Sections surprised the members with stunts that were not scheduled in the program and were kept absolutely under cover until the psychological moment. Without doubt the most spectacular of the stunts was the Metropolitan Section contest, which resulted in H. L. Zimmerman driving a Reo Flying Cloud coupe down the front steps of the hotel, said Reo having been discovered in the hotel lobby in the early hours of the morning by those getting down for a trip around the Hill Course before freakfast. As made evident by the accompanying photograph, it was no simple stunt to get the car out of the hotel. The selection of the Flying Cloud was, of course, logical in view of the fact that the Metropolitan Section ideal car determined in the questionnaire contest last winter corresponded with it so closely in specifications.

When Mr. Zimmerman was announced as the owner of the Reo Flying Cloud coupe shortly after midnight on the night of the Grand Ball, his speech of acceptance was brief but to the point. Hhe thought, he said, it was a mighty fine stunt and he would like to shake hands with the man that had the idea. After driving the car out of the lobby and down the front steps the next morning he intimated that he



TRAPSHOOTING, ARCHERY AND THOSE RESPONSIBLE FOR THE *DAILY SAE*

W. H. Miller, Who Started the Trapshooting Tournament by Breaking 50 Targets Out of a Possible 50, Appears at Upper Left with J. C. Geniesse at His Right. The Staff of the *Daily SAE*, Reading from Left to Right, Were Foust Childers, E. V. Rippingille, O. Lee Harrison, W. A. Moffett, Milton J. Morgan, and W. M. Carson. Mrs. W. L. McGrath, Chairman of the Archery Committee and Winner of the Tournament, Appears at the Extreme Right at Lower Left

was still having difficulty in keeping his knees from shaking.

Friday night the Detroit High Hat orchestra, led by Fred Cornell and composed of Phil Overman, H. A. Hansen, E. V. Rippingille, "Bunny" Dawe and E. A. Anderson, entertained the members at dinner, the music being so good that the Body Session had to be postponed until the last piece was played, as the members would not leave the dining-room so long as there was hope of more music.

Thursday night the Detroit Section entertained the members at the Club High Hat, the most successful night club ever promoted, judged on the basis of couples per square foot of floor space and real jazz, again furnished by the Detroit High Hats. Among the celebrities at the night club were Charlie Crawford, who almost suffered an ignominious exit, as he was mistaken for some of the local light-fingered talent. A more complete account of the stunt will be found on the front page of the Friday issue of the *Daily SAE*, reproduced on the opposite page.

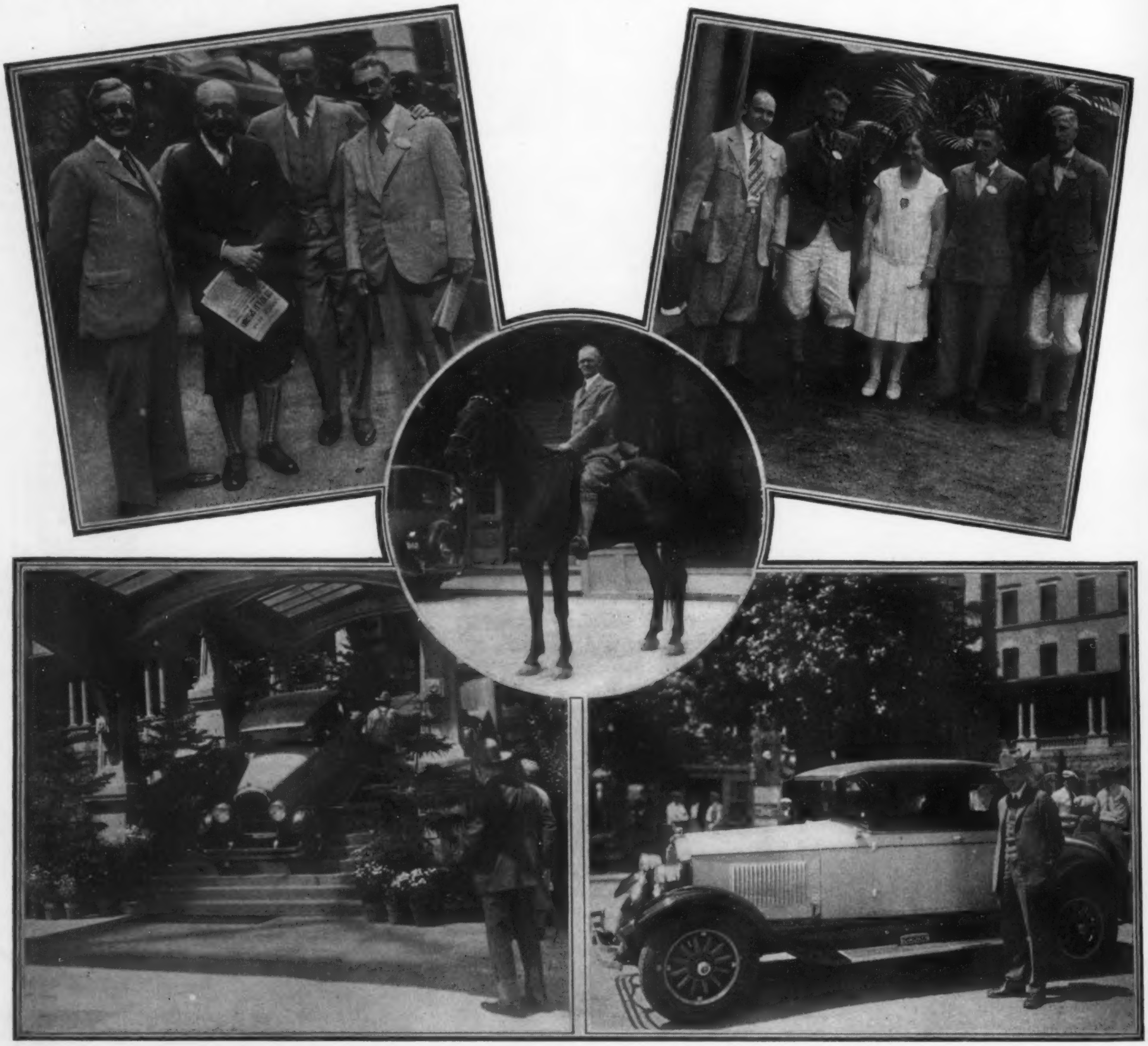
Thursday night the Milwaukee Section distributed to each member, guest and lady in the main dining-room a bottle of a certain beverage that in former years was closely associated with the City of Milwaukee.

The S.A.E. Annual Field Day was held on the lawn in front of the Pluto Water Bottling Works on the only afternoon that could be considered warm. Through the courtesy of the Cleveland Section, however, a soda-water and ice-cream stand was established by the local troop of Boy Scouts, ice-cream and soda water (not Pluto) being given out.

As in former years the Chicago Section followed its gracious custom of giving corsage bouquets to the ladies on the evening of the Grand Ball.

A. A. A. CONTEST BOARD HOLDS MEETING

The presence of a representative group of engineers at the Summer Meeting was taken advantage of by the Contest Board of the American Automobile Association to hold a meeting for the general discussion of stock-car trials and



THE MET-SECTION STUNT COMMITTEE, THE CAR AND THE WINNER

H. L. Zimmerman, the Winner of the Met-Section Stunt, with the Car That He Drove Away from the Summer Meeting as His Property, Appear in the Lower Views. The Met-Section Committee Responsible for the Novel Stunt Appear at the Upper Right, the Members, Reading from Left to Right, Being "K" Glynn, C. L. Drake, "Judy" McCormick, C. B. Veal, and Sid Dresser, Chairman. T. J. Litle, Jr., F. E. Moskovics, Capt. Eddie Rickenbacker, and W. G. Wall, Members of the A.A.A. Contest Board, Appear at the Upper Left. J. G. Swain (Insert) Directed the Ladies' Treasure Hunt

THE DAILY SAE

French Lick Springs, Indiana, Friday, May 27, 1927

CAPITOL TEAM WINS

JAZZY THRILLS FEATURE CLUB

Detroit Baggage Car Stunt Keeps Crowd Merry Until Dawn

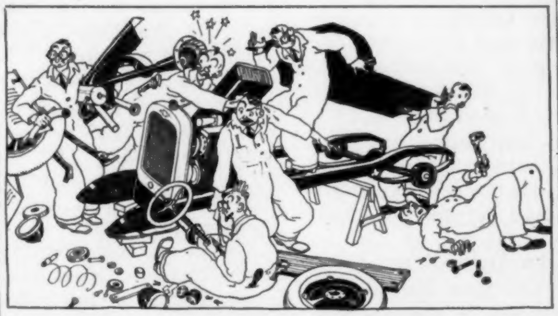
In introducing the "Club High Hat" to French Lick Springs last evening the Detroit Section solved a long felt want—what and how to do with sleepless hours when the heart aches for the bright lights and the sobbing saxophone. And man, did that jazzbo orchestra wail! The strains would have brought tears to even such an unsophisticate at Texas Guinan. Stay with us feet, the music pleaded, for as long as there is a twitch in the body there is life.

The Club consisted of a 60 foot baggage car, floor boarded for dancing and trimmed with red and white bunting. Lights were low and soft. Refreshments were served that were so refreshing you could hardly realize you were dancing at all.

The car was parked down the track a short distance from the hotel with a red and white high hat hung over the entrance. Steps were built up at the end of the baggage car and as you entered and started to dance you felt you were again back on Broadway. The crowd that ebbed and flowed about you carried you hither and thither.

Phil Overman, H. A. Hansen, Fred Cornell, E. V. Rippingille and "Bunny" Dawe furnished the palpitating music. Into the wee hours of the morning a constant stream kept wending their way over to the Club, even until the flickering lights in the hotel windows blinked and went out—and still the saxophone moaned.

EASY TO DESIGN 'EM BUT--



CARD WILL BRING THE DAILY SAE

Those desiring a complete set of the four issues of The Daily SAE may obtain them after the summer meeting by writing to the Delco - Remy Corporation, Anderson, Ind., publishers of this year's convention daily. For your convenience, addressed post-cards will be placed on the dining room tables before breakfast Saturday morning.

MAKE RESERVATIONS

Those wishing reservations on proposed special trains for Detroit, Cleveland and New York at 5:45 p.m. Saturday are requested to notify the porter's desk in the lobby. Reduced fare certificates also should be validated at the desk.

LADIES FAIL WITH CUPID'S WEAPONS

One Finds She Can Hit Target Best By Not Looking At It

William Tell would have been as safe standing before the target in the preliminary Ladies Archery contest yesterday afternoon as doing his home-brew work in the sanctuary of his kitchen.

"I'm just not going to look at the target at all," exclaimed one woman, "because I didn't look at it this time and I hit it." Another woman complained that she would like a man's sized bow and arrow. Boy, what a wallop she must have!

Some of the women, after discovering that they could shoot quite a distance, kept trying for distance the remainder of the afternoon. Two women, keen observers, discovered that two of the arrows were curved, yet just what difference this made we were not able to discover.

The women were just getting the range and will start the contest in earnest this morning at 10 o'clock. Mrs. W. L. McGrath, chairman and F. A. Cornell are acting as a ways and means committee to get the arrows to the target.

WASHINGTONIANS MAKE RECORD IN ASSEMBLING CAR

Gallery Roars As Engineers Fumble; One Team Forgets Wheels

STUNT IS BIG SUCCESS

The guessing contest on the time of the chassis assembling contest was won by Mr. J. A. Gelzer, Wagner Electric Co., St. Louis, Mo., with a guess of 10 minutes flat. There were 252 ballots cast.

The Washington team, including several deft-handed trouble-shooters from the U. S. Bureau of Standards, showed the way yesterday to the six other teams competing in the chassis assembling contest.

The Washingtonians got their Chevrolet half-ton truck all put together in the remarkable time of six and one-half minutes, after which W. H. Ragsdale piloted it five times around the loop of roadway in front of the hotel. J. H. Hunt, S. A. E. president and one of the judges, gave Ragsdale the checkered flag just 10 minutes and 22.6 seconds after the starting bomb had sent the teams leaping to their tasks.

Winners Given Bags

Besides a gorgeous silver cup which goes to the Washington team, the individual members each received a

(Continued on Page Two)

THESE GIRLS NEED NO SASH WEIGHT

HE MADE A RINGER

HAS HUNT GOT NEW JOB?

A. J. Neerken while driving near Detroit recently was startled to see J. H. Hunt emerge from a side road driving a Chevrolet truck filled with gravel.

racing rules. The meeting was held at 12:30 on Thursday, May 26, and was presided over by the Chairman of the Contest Board, Capt. E. V. Rickenbacker.

Among those present were Past-President T. J. Lítle, Jr., First Vice-President W. G. Wall and F. E. Moskovics, who, together with Captain Rickenbacker, appear in one of the accompanying illustrations. After a general discussion of the situation it was decided to approach the automobile manufacturers through the National Automobile Chamber of Commerce on the question of whether they desire stock-car racing.

DELCO-REMY PUBLISHES *Daily SAE*

Possibly the best feature of the Summer Meeting was the *Daily SAE*, printed this year by the Delco-Remy Corporation. Not only were the technical sessions and sports reported in real newspaper fashion, but through the cooperation of A. K. Rutherford, the local photographer, photographs of all the events were rushed to Louisville, where cuts were made in time for the following issue.

Each issue was further enlivened by the inclusion of such special features as a burlesque on the Inquiring Reporter in the form of Ask Me Another Question, a comic strip cartoon, and one or more satirical and humorous descriptions of the circumstances leading to automotive inventions. This latter series, headed True Stories of Auto Inventions, some of which are reproduced elsewhere in this issue of THE JOURNAL, afforded an excellent opportunity to poke fun at various accessories and their manufacturers. These humorous features enabled all to start each day with a smile, as the *Daily SAE* was distributed before breakfast each morning.

The *Daily SAE* was published by the Delco-Remy Corporation with the cooperation of the Campbell-Ewald Co. Credit for the best issues of recent years is due to the editorial staff which was composed of O. Lee Harrison, editor-in-chief; E. V. Rippingille, assistant editor-in-chief; William A. Moffett, managing editor; Foust Childers, business manager; Milton J. Morgan, technical manager; and Dudley M. Carson, sporting editor.

SUCCESSFUL MEETING DUE TO MEMBERS

The success of the 1927 Summer Meeting was, as is the case with every meeting of the Society, due very largely to the active support of the members of the Meetings and Sports Committees who directed the various sports.

"Clayt" Hill, as chairman of the Meetings Committee, was, of course, responsible for the general program, but the smoothness with which the various events were run off proved the wisdom of his selection of F. G. Whittington as Chairman of the Sports Committee. The complete personnel of the committees responsible for the Summer Meeting follows:

SPORTS COMMITTEE

F. G. Whittington, *Chairman* — E. V. Rippingille, *Vice-Chairman*

E. W. Austin, *Announcer*

TENNIS

B. J. Lemon, *Chairman* — D. S. Cole

GOLF

J. H. McDuffee, *Chairman*

R. H. DeMott — F. W. Marschner

HORSESHOES

W. L. McGrath, *Chairman* — F. J. Lane

TIMERS AND JUDGES

J. C. Talcott, *Chairman*

A. W. S. Herrington — Charles Hollerith

W. F. Rockwell

TRAPSHOOTING

R. S. Ellis, *Chairman* — A. J. MacDowel

TRACK

F. K. Glynn, *Chairman* — F. M. Young

LADIES' ENTERTAINMENT COMMITTEE

Mrs. A. W. S. Herrington, *Chairman*

Mrs. R. H. DeMott — Mrs. C. T. Klug
Mrs. F. M. Germane — Mrs. W. L. McGrath
Mrs. Jack Gray — Mrs. E. V. Rippingille
Mrs. C. E. Heywood — Mrs. Lon R. Smith
Mrs. H. L. Horning — Mrs. J. F. Winchester

TREASURE HUNT

Mrs. Jack Gray — Mrs. C. T. Klug

J. G. Swain

BRIDGE

Mrs. F. M. Germane, *Chairman*

Mrs. B. Brede — Mrs. J. F. Winchester

ARCHERY

Mrs. W. L. McGrath, *Chairman* — F. A. Cornell

PRIZES AND SCORING

Miss J. A. McCormick

SUBSCRIBERS TO THE PRIZE FUND

The prizes won at the Summer Meeting were made possible by the Prize Fund established by companies in the automotive industry. The present fund was established this year, the Meetings Committee having given every company in the industry an opportunity to contribute not more than $10. The companies contributing to the Prize Fund are listed hereinafter, the total number being 282. The present fund, in addition to providing the prizes for the 1927 Summer Meeting, will purchase those for the 1928 and 1929 Summer Meetings.

The prizes, constituting one of the most pleasant features of the Summer Meetings, were exhibited during the meeting in showcases at the Information Desk.

A. C. Spark Plug Co.
Akron-Selle Co.
Allbestos Corporation
American Bosch Magneto Corporation
American Brake Materials Corporation
American Chain Co., Inc.
American Felt Co.
American Rolling Mill Co.
American Steel & Wire Co.
Amtorg Trading Corporation
Arco Co.
Asbestos Mfg. Co.
Auburn Automobile Co.
Autocar Co.
Automotive Daily News Publishing Corporation
Badger Mfg. Corporation
Bailey Mfg. Co.
Bakelite Corporation
Barnes-Gibson-Raymond, Inc.
Bearings Co. of America
Beck-Frost Corporation
Bendix Brake Co.
Bendix Corporation
Bijur Lubricating Corporation
Bliss & Laughlin, Inc.
Bohn Aluminum & Brass Corporation.
Borg & Beck Co.
Bound Brook Oil-Less Bearing Co.
Braden Steel & Winch Co.
Bragg-Kliesrath Corporation
Briggs & Stratton Co.
Brill Co., J. G.
Brown, Louis B., Minsch Monell & Co., Inc.
Buda Co.
Budd Mfg. Co., Edward G.
Budd Wheel Co.
Buick Motor Co.
Bundy Tubing Co.
Bunting Brass & Bronze Co.
Byrne, Kingston & Co.
C. G. Spring & Bumper Co.
Campbell-Ewald Co.
Carpenter Steel Co.
Carr Co., F. S.
Carter Carburetor Corporation
Carter Co., George R.
Central Alloy Steel Corporation
Chadwick Mfg. Co.
Champion Porcelain Co.
Champion Spark Plug Co.
Chandler - Cleveland Motors Corporation
Chevrolet Motor Co.
Chilton-Class Journal Co.
Christensen Air Brake Co.
Chrysler Corporation
City of Detroit, Department of Street Railways
Clark Equipment Co.
Cleveland Graphite Bronze Co.
Cleveland Twist Drill Co.
Cleveland Wire Spring Co.
Climax Molybdenum Co.
Clum Mfg. Co.
Columbia Axle Co.
Consolidated Gas Co. of New York
Continental Motors Corporation
Continuous Torque Transmission Co.
Cook Spring Co.
Cousins Tractor Co.
Covert Gear & Mfg. Co.
Craveroiler Co. of America
Cunningham, Son & Co., James
Cutler-Hammer Mfg. Co.
Dahlstrom Metallic Door Co.
Dayton Wire Wheel Co.
De'Jon Electric Corporation
Delco-Remy Corporation
Deppe Motors Corporation
Detroit Carrier & Mfg. Co., Division of Kelvinator Corporation
Detroit Edison Co.
Detroit Gear & Machine Co.
Detroit Seamless Steel Tubes Co.
Detroit Steel Products Co.
Dickerson Steel Co.
Dickinson Cord Tire Corporation
Dill Mfg. Co.
Ditzler Color Co.
Dole Valve Co.
Donahue Varnish Co., F. J.
Dura Co.
Durand Steel Locker Co.
Durant Motor Co.
Duratex Corporation
Durham Co., P. J.
Eaton Axle & Spring Co.

(*Continued on p.* 803)

OPERATION AND MAINTENANCE

STATE MOTOR-VEHICLE REGULATIONS

Subcommittee of Operation and Maintenance Committee To Study Regulations

A preliminary study by Chairman Scarr of the Operation and Maintenance Committee's Subcommittee on Motor-Vehicle Regulations indicates that State regulation as applied to motor-vehicle operation has been brought from almost an entire lack of uniformity to a condition approaching a reasonable degree of similarity among the several States. It indicates, however, that there remain many differences in rules affecting both operation and maintenance that in the interest of better fleet management must be brought into closer harmony. As an example of such rules causing difficulties to large fleet operators who are, in general, engaged in inter-state service, attention is called to the wide variation in the location and color of motorcoach marking lights.

In addition to the difficulties arising from the lack of uniformity of State regulations, there are certain matters generally required by States which affect fleet operation and maintenance. An example of this is the present requirements for registration of engine numbers that makes it difficult to interchange engines between vehicles as is often required in fleet maintenance.

The Subcommittee on Motor-Vehicle Regulations proposes to study the motor-vehicle regulations and laws of all the States and prepare a report on the variations found in them that affect motor-vehicle operation and maintenance, cooperating fully with others who are interested in this problem. It further proposes to establish, if possible, such relations with regulatory bodies which are frequently taking steps to control the construction and operation of motor-vehicles, as will permit close cooperation with such authorities in the establishment of sound and uniform measures.

The members of the Subcommittee are F. J. Scarr, chairman, Scarr Transportation Service; F. D. Howell, Motor Transit Co.; Adrian Hughes, Jr., United Railways & Electric Co. of Baltimore; J. F. McMahon, Yellow Taxi Corporation; H. V. Middleworth, Consolidated Gas Co. of New York; and R. E. Plimpton, *Bus Transportation.*

ARMY VEHICLE OPERATING CHARGES

Depreciation on Motor-Vehicles Established at 20 Per Cent Per Year

The *U. S. Army Speedometer* has published the accompanying table compiled by the War Department which places the life of a motor-car or motor-truck at 5 years, the amortization of six types of vehicle being shown by approximate daily charges used in figuring depreciation. It is stated that at times the Army provides motor-vehicles for other departments of the Government and the commanding officer under whom the transaction is made is frequently uncertain as to the basis on which to charge for such transactions. The table is reproduced in this issue of THE JOURNAL as indicating the division of charges for the operation of this class of vehicle as a matter of interest to those who are operating similar vehicles.

STUDY OPERATING ACCOUNTING

Preliminary Classifications and Definitions Discussed at Joint Meeting

A joint meeting of the Nomenclature and Accounting Subcommittees of the Society's Operation and Maintenance Committee in New York City on May 19 was devoted to discussion of the preliminary classifications for accounting that have been received by the Committee. There are about 30 of these and arrangements are being made to communicate with 50 or more leading operators of motor-vehicles to make the data more completely representative of the practice of the larger companies.

The Subcommittee on Nomenclature submitted a report indicating that two questionnaires are to be sent out, the first to be mailed immediately to include terms that are used and misused in fleet operation and maintenance and asking that a definition of each be submitted. After the work of the Accounting Subcommittee is further advanced a second questionnaire will be sent out regarding terms that are used in various accounts.

A feature of the meeting was a report on the study of accounting that a committee of the American Petroleum Institute is making and that was started 2 years ago to develop a complete system for oil companies. It is expected that next year accounting of transportation costs will be taken up and assurances were given that the Institute's committee would cooperate fully in the work of the Society's committee.

At the next meeting of the Committee, which will probably be held during the third week in June, W. F. Banks, of the Motor Haulage Co., Inc., will present an analysis of the very complete accounting system used by his company.

Those present at the meeting of the Committee were of the Operation and Maintenance Committee and Subcommittee on Accounting, R. E. Plimpton, chairman, *Bus Transportation*; L. C. Albrecht, Bordens Farm Products Co.; D. L. Bacon, New York, New Haven & Hartford Railroad; W. F. Banks, Motor Haulage Co., Inc.; D. Blanchard, *Operation and Maintenance*; F. K. Glynn, chairman of the Nomenclature Subcommittee, American Telephone & Telegraph Co.; W. R. Gordon, Pierce-Arrow Motor Car Co.; M. W. Mattison, American Petroleum Institute; H. V. Middleworth, Con-

	Dodge	Cadillac	White	G.M.C.	Class B	Mack
Amortization Based on a 5-Year Life	$0.50	$1.29	$1.75	$0.82	$2.38	$2.51
Housing	0.50	0.50	0.50	0.50	0.50	0.50
Washing and Cleaning—Labor, Materials and Equipment	0.16	0.19	0.18	0.16	0.17	0.18
Driver's Wages Based on the Pay of an Enlisted Private	2.13	2.13	2.13	2.13	2.13	2.13
and Allowances for Quarters and Subsistence	0.75	0.75	0.75	0.75	0.75	0.75
Cost of Supervision by Commissioned Officer	2.25	2.25	2.25	2.25	2.25	2.25
Gasoline and Lubricants	0.82	0.91	1.30	0.63	0.75	0.75
Tires, Tubes and Rims	0.46	1.30	1.44	0.70	1.83	2.04
Spare Parts and Accessories, Replacements	0.59	0.87	0.68	0.45	0.82	0.94
Labor Cost of Repairs						
Total Daily Cost	$8.16	$10.19	$10.98	$8.39	$11.58	$12.05
Cost per Mile	$0.07	$0.13	$0.18	$0.14	$0.39	$0.45

solidated Gas Co. of New York; B. T. Pudifin, American Railway Express Co.; F. E. Schmitt, *Engineering News-Record*; and R. S. Burnett, Manager of the Society's Standards Department.

OPERATION RESEARCH PROGRAM

Number of Projects Discussed at French Lick Springs Meeting of Committee

An important part of the Operation and Maintenance Committee's program this year is to promote research subjects and investigations that the motor-vehicle fleet operators feel will result in definite improvements in their equipment and operations. These studies will be carried forward by the Society's Research Committee and the Research Department rather than by the Operation and Maintenance Committee itself. The latter is, however, represented unofficially on the Research Committee by A. W. Herrington and J. F. Winchester. At a meeting of the Committee at French Lick Springs on May 27 that was called especially for the purpose of discussing research subjects, a number of suggestions by members of the Committee were considered, among which were:

- Methods of lubrication
- Effects of various kinds of road resistances on commercial vehicles and to clarify the economics of highway improvement
- Spark-plugs for heavy motorcoach operations
- Adequate rear-end signal device for use in heavy traffic
- Semi-automatic spraying methods for outside cleaning of vehicles
- Methods of purchasing and checking the quality of lubricants in quantity purchases
- The comparative effects of solid, cushion and pneumatic tires on the mechanical condition and the operation of motor-vehicles
- Mileage recording instruments

It was decided to refer the following to the Research Committee for further study:

- Methods of purchasing and testing lubricating-oils
- Solid cushion and pneumatic tire effects on the mechanical condition and operation of motor-vehicles
- Mileage recording instruments
- Effects of road resistance on commercial vehicles

Progress of the Research Committee on these and other investigations that it is making that will be of interest to the motor-vehicle fleet operators, will be reviewed from time to time in the Operation and Maintenance Department of subsequent issues of THE JOURNAL. Those attending the meeting of the Operation and Maintenance Committee meeting were R. E. Plimpton, chairman; F. K. Glynn, G. R. Gwynne, A. W. Herrington, H. V. Middleworth and R. S. Burnett.

MOTORCOACH OPERATION BY RAILWAYS

Route-Miles and Number of Vehicles Substantially Increased Last Year

In connection with the relation of the growth of the motorcoach industry and its influence on the business of the electric railway lines, figures released by the American Electric Railway Association indicate that the electric railway companies representing about 78 per cent of the total trackage operated 1,964,000,000 revenue car-miles, an increase of 23,000,000 in 1926 over 1925, in addition to which the motorcoach miles similarly operated was 123,350,000, an increase of about 60 per cent or 47,000,000 motorcoach-miles, over 1925. The number of miles of motorcoach routes operated in 1926 increased by 1800 miles, totaling 5650 as against 32,096 miles of electric railway lines. The statement adds that in the motorcoach operations 1220 new motorcoaches were added to the service during 1926, which valued at $7,500 each represented an investment of $9,150,000. The increased motorcoach service cost about $19,500,000 in operating expense and $9,150,000 in investment and equipment, a total of $28,650,000.

The report also indicates that operations had improved somewhat in the larger municipalities and medium-sized cities, due probably largely to the congestion and inconvenience of operating private automobiles, whereas operation in the smaller communities and on interurban lines did not fare so well because of competition by automobiles and the large aggregate investment necessary to maintain service. It was also stated that the importance of these small lines in the electric railway industry as a whole is slight, the total number of passengers carried amounting to less than 1 per cent of the total traffic of the industry.

CHARLES L. SHEPPY

ANNOUNCEMENT of the death of Charles L. Sheppy is a matter of deep regret that will be felt by the many members who knew him personally and to whom he had become a familiar figure in discussions at Society meetings. Mr. Sheppy had suffered protracted illness due to heart disease and, with hope of regaining health, had gone to the South, where he passed away on May 1, at Summerville, S. C. By his death the automotive industry has lost another of its American pioneers and the Pierce-Arrow Motor Car Co. a veteran of 29 years' continuous service who had joined that organization in 1898 as experimental engineer. At the time of his death Mr. Sheppy was chief engineer, a position he had held for the last 5 years.

Much of the credit for the launching and progress of the Pierce-Arrow Motor Car Co. in the automobile field is due to Mr. Sheppy, who was responsible to a large extent for the production, almost 30 years ago, by the George N. Pierce Co., then building bicycles, of the Pierce Motorette, a little two-passenger automobile driven by a 2¼-hp. DeDion single-cylinder engine mounted over the rear axle. Among his most recent achievements are the Pierce-Arrow Series-80 car and the line of Series-36 models brought out in the autumn of 1926. He drove one of the early Pierce-Arrow cars that won honors in the grueling New York City-to-Pittsburgh endurance run in 1903 and was a prominent participant in the first Glidden tour from New York City to the White Mountains in 1902 and in later Glidden tours. Many of the improvements in the Company's cars and trucks were his ideas and were developed by him personally before they were incorporated in production.

Mr. Sheppy was also a veteran member of the Society, which he joined in July, 1910, and had been active for a number of years in the Buffalo Section. He was active in 1925 on the Advisory Committee on Automobile Locks and in 1926 on the Tire and Rim Division of the Standards Committee, and in the latter year was appointed a member of the Lighting Division.

He was a native New Yorker, having been born on Sept. 21, 1871, at Gratwick, Erie County, N. Y., and from 1898 to 1900 was engaged in designing and constructing an experimental motor-car. During 2 years prior to this he was engaged in building and equipping a factory at Hamburg, Germany, for the Pure Oil Co. All of his work in the automotive field was done for the Pierce-Arrow Motor Car Co., a most unusual record of continuous service with a single company of unusual longevity in the industry.

PRODUCTION ENGINEERING

PRODUCTION MEETING IN SEPTEMBER

Sessions To Be Held in Cleveland and Detroit on Account of Exhibitions

The 1927 Production Meeting will be held on Sept. 19 to 22, inclusive, the first 2 days being at the Hotel Winton, Cleveland, and the second 2 at the Hotel Statler, Detroit. These arrangements were approved by the Meetings Committee on the recommendation of the Production Advisory Committee to make it possible for the Detroit members attending the Production Meeting to attend the exhibit of the American Machine Tool Builders Association in Cleveland and for the Cleveland members to attend the exhibit of the American Society for Steel Treating in Detroit. Reservations are being made on the Detroit night boat for all members leaving Cleveland for Detroit on Tuesday night. The stag carnival, which has been such a success in past Production Meetings, will be held on Tuesday evening at the Hotel Winton.

The arrangements for the Production Meeting have been put in the hands of a Subcommittee under the chairmanship of Prof. John Younger. The personnel of the Subcommittee was extended to include the personnel of the Production Advisory Committee, as it was appreciated that the interest of the two committees overlap to a large extent. The personnel of the complete Subcommittee follows:

Prof. John Younger, *Chairman*	Ohio State University
E. P. Blanchard	Bullard Machine Tool Co.
Eugene Bouton	Chandler-Cleveland Motors Corporation
W. G. Careins	Nash Motors Co.
F. H. Colvin	*American Machinist*
T. B. Fordham	Delco-Light Co.
A. R. Fors	Continental Motors Corporation
Paul Geyser	Yellow Truck & Coach Mfg. Co.
J. F. Guider	Pierce-Arrow Motor Car Co.
W. W. Norton	Autocar Co.
Erik Oberg	*Machinery*
C. C. Stevens	New Departure Mfg. Co.
W. K. Swigert	Stutz Motor Car Co.
E. A. Taylor	Yellow Sleeve Valve Engine Works

The subjects that should be included in the technical program for the Production Meeting are now being studied by the Subcommittee and suggestions will be appreciated regarding subjects and authors.

PRODUCTION STANDARDS DATA SHEETS

Adopted Standards for Production Engineers To Be Printed on 8½x11-In. Ring-Binder Sheets

At the Standards Committee Meeting of the Society last January, the first production standard relating to machine-tools and machine-tool equipment was approved and subsequently adopted by the Society. The members of the Production Division of the Standards Committee had indicated preference for the 8½ x 11-in. ring-binder sheets rather than to include the production standards in the S.A.E. HANDBOOK. At a meeting in March of the Production Advisory Committee, preference was also indicated for the larger-size publication, but, to make sure that these opinions represent a fair cross-section of the preference of production engineers in general, a canvass was made by letter among all the members of the Production committees. The result of this canvass was the confirmation of the selection of the 8½ x 11-in. sheets by a considerable majority. The advantages and disadvantages of printing the production standards on the larger sheets, as well as in the present S.A.E. HANDBOOK size, were laid before the Council of the Society at its meeting on May 5 to give thorough consideration to the matter from all points of view before a decision was reached as to which size to adopt. The Council approved the publication of the production standards on the 8½ x 11-in. size, and the S.A.E. Recommended Practice for T-Slots, Bolts, Nuts, Tongues and Cutters, which was adopted at the Annual Meeting last January, will be printed and distributed as soon as possible. The text of the report was printed on p. 34 of the January, 1927, issue of THE JOURNAL. The report was also approved by the Society as that of the Sectional Committee on Small Tools and Machine-Tool Elements organized under the procedure of the American Engineering Standards Committee and sponsored by this Society, the American Society of Mechanical Engineers and the National Machine-Tool Builders Association. The Sectional Committee's report was likewise approved by the other sponsors and finally passed upon by the American Engineering Standards Committee as Tentative American Standard.

DRIVING SPEEDS FOR MACHINERY

Standard Suggested To Remedy the Confused Conditions That Now Exist

It is apparent that the present condition with regard to both the driving and driven speeds of machinery is chaotic on account of the random selection of such speeds. The result is that machinery manufacturers are faced with a difficult problem in designing and building of their machinery. Probably a possibility of accomplishing some degree of standardization in this field was called to mind by recent activity toward establishing standard mounting-dimensions for electric motors. Much stretching of the imagination is not required to appreciate the difficulties of manufacturers, jobbers, dealers, and the users of machinery in connection with the variety of pulleys, clutches, gears, sprockets, and similar devices that they have to make and carry in stock. This point was illustrated some time ago in connection with a project on which the Agricultural Power-Equipment Division of the Society's Standards Committee was working, when it was stated that one company had found that it carried well over 2000 different pulleys in stock to meet its varying requirements, whereas probably not more than 200 or 300 would have been required if reasonable standardization could have been had.

The National Electrical Manufacturers Association has requested the American Engineering Standards Committee to arrange for a general conference to discuss the feasibility of standardizing a progressive series of driving speeds, stating that while the needs for simplification of driving and driven connections has been apparent for years, particularly to producers of electric motors, steam-engines and other primary units, nothing has been accomplished because without co-ordination and standardization of speeds of driven and driving machinery considered together, no satisfactory solution of the problem can be had.

The American Engineering Standards Committee probably

will arrange a general conference in the near future, following which, if it is decided to proceed with the project, the directly interested National industrial groups will be invited to organize a Sectional Committee under the procedure of the American Engineering Standards Committee for the standardization of machinery driving-speeds,

SHELL END-MILLS AND BOLTS

Proposed Standard Submitted for Comments Before Being Approved by Committee

Milling-cutters is one of the important projects that have been undertaken by the Sectional Committee on Small Tools and Machine-Tool Elements, for which the Society, the American Society of Mechanical Engineers and the National Machine-Tool Builders' Association are sponsors under the procedure of the American Engineering Standards Committee.

At a conference held 2 years ago in the City of Washington under the auspices of the Division of Simplified Practice of the Department of Commerce, the milling-cutter manufacturers proposed a program for the simplification of the varieties and sizes of milling-cutters for stock, with the understanding that a program of standardization of the sizes and dimensions of milling-cutters would be undertaken. Accordingly, at a conference held during the machine-tool exhibit in New Haven, Conn., last September, it was decided to organize a Subcommittee on Milling-Cutters, under the Sectional Committee. This was done in December at New York City with C. W. Machon, of the Brown & Sharpe Mfg. Co., as chairman. The Society's representatives on the Subcommittee are H. P. Harrison of the H. H. Franklin Mfg. Co., and D. W. Ovaitt, of the Buick Motor Car Co. The Subcommittee is comprised of 22 members representing cutter and machine-tool manufacturers and user industries including the electrical, automotive and railroad groups, the Navy Department and a representative of the technical press.

If the mechanical industries respond favorably to this program of standardization of milling-cutters, it is probable that the Subcommittee will continue its work on other types of cutter and their mounting dimensions. In this connection, reference is made to the new standard for spindle-ends and arbors for milling-machines that was announced by the milling-machine manufacturers' group of the National Machine-Tool Builders' Association and printed on p. 428 of the April issue of THE JOURNAL.

The following report, when approved by the Sectional Committee, will be submitted to the sponsors for their action before it is finally passed on by the American Engineering Standards Committee for adoption as an American Standard. When the report is so submitted to the Society, it will be referred to the Production Division of the Standards Committee for recommendation in accordance with the Society's regular Standards Committee procedure. However, the Society as one of the sponsors requests that the members and other readers of THE JOURNAL study the report and send their comments on it to the Standards Department of the Society in New York City so that they may be referred to the Subcommittee of the Sectional Committee for consideration before the report progresses further toward final adoption.

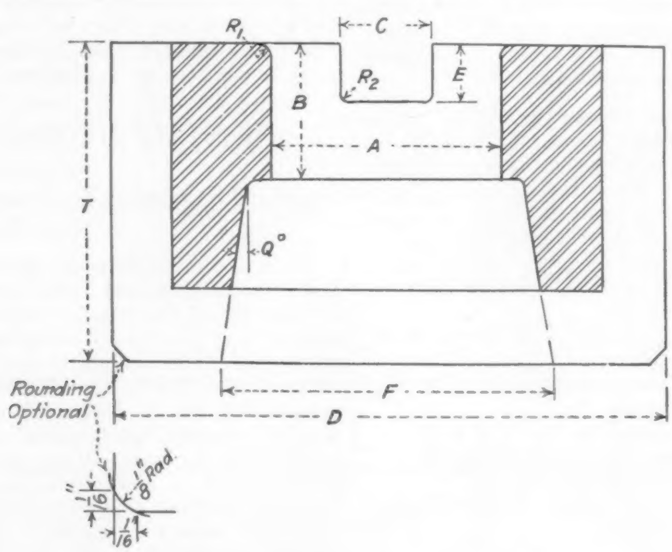
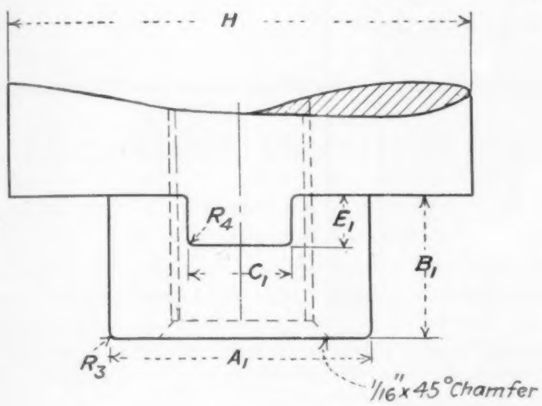


TABLE 1—DIMENSIONS OF SHELL END-MILLS

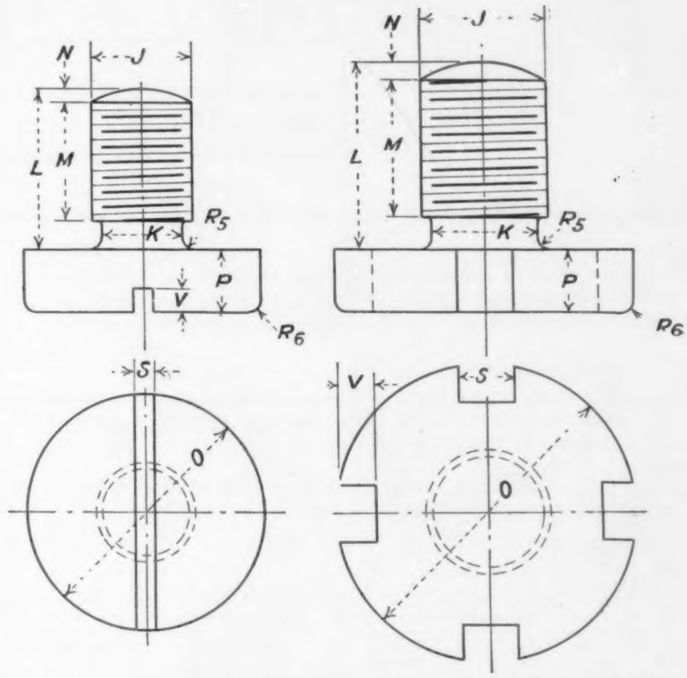
Size or Diameter (D)	Width of Mill (T)	Hole: Diameter (A), Maximum	Hole: Diameter (A), Minimum	Hole: Depth (B), Maximum	Hole: Depth (B), Minimum	Hole: Corner Radius (R_1)	Driving Slot: Width (C), Maximum	Driving Slot: Width (C), Minimum	Driving Slot: Depth (E), Maximum	Driving Slot: Depth (E), Minimum	Driving Slot: Fillet Radius (R_2)	Counterbore: Maximum Diameter[1] (F)	Counterbore: Angular Decrease (Q deg.)
6	2¼	2.0005	2.0000	1 1/64	1	1/32	0.762	0.758	29/64	7/16	1/16	3 ½	15
5½	2¼	2.0005	2.0000	1 1/64	1	1/32	0.762	0.758	29/64	7/16	1/16	3 ¼	10
5	2¼	1.5005	1.5000	1 1/64	1	1/32	0.637	0.633	25/64	3/8	1/16	3	10
4½	2¼	1.5005	1.5000	1 1/64	1	1/32	0.637	0.633	25/64	3/8	1/16	2 ½	10
4	2¼	1.5005	1.5000	1 1/64	1	1/32	0.637	0.633	25/64	3/8	1/16	2 ¼	5
3½	1⅞	1.2505	1.2500	49/64	¾	1/32	0.512	0.508	19/64	9/32	1/32	1 ⅞	5
3	1¾	1.2505	1.2500	49/64	¾	1/32	0.512	0.508	19/64	9/32	1/32	1 ⅝	5
2¾	1⅝	1.0005	1.0000	49/64	¾	1/32	0.387	0.383	15/64	7/32	1/32	1 ½	5
2½	1⅝	1.0005	1.0000	49/64	¾	1/32	0.387	0.383	15/64	7/32	1/32	1 ⅜	0
2¼	1½	1.0005	1.0000	49/64	¾	1/32	0.387	0.383	15/64	7/32	1/32	1 ¼	0
2	1⅜	0.7505	0.7500	49/64	¾	1/32	0.324	0.320	13/64	3/16	1/32	15/16	0
1¾	1¼	0.7505	0.7500	49/64	¾	1/32	0.324	0.320	13/64	3/16	1/32	15/16	0
1½	1⅛	0.5005	0.5000	41/64	⅝	1/32	0.262	0.258	11/64	5/32	1/64	11/16	0
1¼	1	0.5005	0.5000	41/64	⅝	1/32	0.262	0.258	11/64	5/32	1/64	11/16	0

[1]Tolerances ± 1/64 in. unless otherwise specified.



PROPOSED STANDARD ARBOR END FOR SHELL END-MILLS

Dimensions for the Various Sizes Are Given in Table 2



Used with Mills Ranging from 1¼ to 2¾ In. in Diameter Inclusive

Used with Mills Ranging from 3 to 6 In. in Diameter Inclusive

PROPOSED STANDARD DRAW-IN BOLT

Dimensions for the Various Sizes Are Given in Table 3

TABLE 2—DIMENSIONS OF ARBOR ENDS FOR SHELL END-MILLS

Diameter of Mills Arbor Will Take	Diameter (A_1)		Depth (B_1)		Corner Radius (R_3)	Maximum Flange Diameter[3] (H)	Flange Driving Keys					Draw-In Bolt Tap[2]	
							Width (C_1)		Depth (E_1)		Fillet Radius (R_4)		
	Maximum	Minimum	Maximum	Minimum			Maximum	Minimum	Maximum	Minimum		Size	Threads per Inch
6	2.0000	1.9995	15/16	59/64	1/32	4	0.7520	0.7480	3/8	23/64	1/32	1	14
5½	2.0000	1.9995	15/16	59/64	1/32	4	0.7520	0.7480	3/8	23/64	1/32	1	14
5	1.5000	1.4995	15/16	59/64	1/32	3	0.6270	0.6230	5/16	19/64	1/32	¾	16
4½	1.5000	1.4995	15/16	59/64	1/32	3	0.6270	0.6230	5/16	19/64	1/32	¾	16
4	1.5000	1.4995	15/16	59/64	1/32	3	0.6270	0.6230	5/16	19/64	1/32	¾	16
3½	1.2500	1.2495	11/16	43/64	1/32	2 ¼	0.5020	0.4980	¼	15/64	1/32	⅝	18
3	1.2500	1.2495	11/16	43/64	1/32	2 ¼	0.5020	0.4980	¼	15/64	1/32	⅝	18
2¾	1.0000	0.9995	11/16	43/64	1/32	1 11/16	0.3770	0.3730	3/16	11/64	1/32	½	20
2½	1.0000	0.9995	11/16	43/64	1/32	1 11/16	0.3770	0.3730	3/16	11/64	1/32	½	20
2¼	1.0000	0.9995	11/16	43/64	1/32	1 11/16	0.3770	0.3730	3/16	11/64	1/32	½	20
2	0.7500	0.7495	11/16	43/64	1/32	1 ¼	0.3145	0.3105	5/32	9/64	1/32	⅜	24
1¾	0.7500	0.7495	11/16	43/64	1/32	1 ¼	0.3145	0.3105	5/32	9/64	1/32	⅜	24
1½	0.5000	0.4995	9/16	35/64	1/32	⅞	0.2520	0.2480	⅛	7/64	1/64	¼	28
1¼	0.5000	0.4995	9/16	35/64	1/32	⅞	0.2520	0.2480	⅛	7/64	1/64	¼	28

[2]All threads to be American Standard Screw Threads, Fine Series, Class 2 Fit.
[3]Tolerances ± 1/64 in. unless otherwise specified.

TABLE 3—DIMENSIONS OF DRAW-IN BOLT FOR FASTENING END-MILL TO ARBOR

Diameter of Shell End Mill	Bolt Size	Threads per Inch[4]	Major Diameter[4] (J)		Recess Diameter (K)		Fillet Radius (R_5)	Min. Length under Head[5] (L)	Length of Threads (M)	(N)	Diameter of Head[5] (O)	Thickness of Head[5] (P)	Corner Radius (R_6)	Keyway or Slot[5]	
			Maximum	Minimum	Maximum	Minimum								Width (S)	Depth (V)
6	1	14	1.000	0.990	29/32	57/64	1/16	1 5/16	1	⅛	2½	⅜	1/16	13/32	⅜
5½	1	14	1.000	0.990	29/32	57/64	1/16	1 5/16	1	⅛	2½	⅜	1/16	13/32	⅜
5	¾	16	0.750	0.741	21/32	41/64	1/16	1 ⅛	13/16	3/32	1⅞	⅜	1/16	11/32	¼
4½	¾	16	0.750	0.741	21/32	41/64	1/16	1 ⅛	13/16	3/32	1⅞	⅜	1/16	11/32	¼
4	¾	16	0.750	0.741	21/32	41/64	1/16	1 ⅛	13/16	3/32	1⅞	⅜	1/16	11/32	¼
3½	⅝	18	0.625	0.617	35/64	17/32	1/16	15/16	11/16	3/32	1½	5/16	1/16	9/32	3/16
3	⅝	18	0.625	0.617	35/64	17/32	1/16	15/16	11/16	3/32	1½	5/16	1/16	9/32	3/16
2¾	½	20	0.500	0.493	27/64	13/32	1/16	13/16	19/32	1/16	1 3/16	5/16	1/16	5/32	⅛
2½	½	20	0.500	0.493	27/64	13/32	1/16	13/16	19/32	1/16	1 3/16	5/16	1/16	5/32	⅛
2¼	½	20	0.500	0.493	27/64	13/32	1/16	13/16	19/32	1/16	1 3/16	5/16	1/16	5/32	⅛
2	⅜	24	0.375	0.368	5/16	19/64	1/16	⅝	7/16	3/64	⅞	¼	1/32	5/32	⅛
1¾	⅜	24	0.375	0.368	5/16	19/64	1/16	⅝	7/16	3/64	⅞	¼	1/32	3/32	⅛
1½	¼	28	0.250	0.244	13/64	3/16	1/16	½	5/16	1/32	⅝	3/16	1/32	1/16	3/32
1¼	¼	28	0.250	0.244	13/64	3/16	1/16	½	5/16	1/32	⅝	3/16	1/32	1/16	3/32

[4]All threads to be American Standard Screw Threads, Fine Series, Class 2 Fit.
[5]Tolerances ± 1/64 in. unless otherwise specified.
Spanner Wrenches are required for 1, ¾, and ⅝-in. bolts.

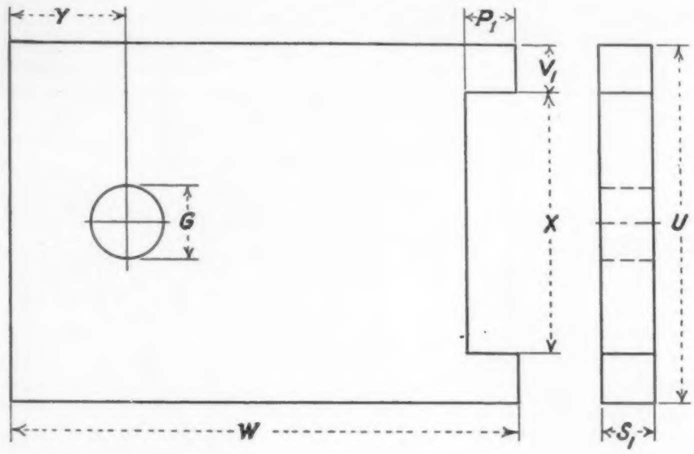


TABLE 4—DIMENSIONS OF WRENCH FOR DRAW-IN BOLT[7] WHICH HOLDS SHELL END-MILL TO ARBOR

Size of Draw-In Bolt	Length (W)			Width (U)			Thickness S_1	Width of Recess (X)			Depth of Prong (P_1)			Width of Prong V_1	Drill Diameter of Hole (G)	(Y)		
	Nominal	Maximum	Minimum	Nominal	Maximum	Minimum		Nominal	Maximum	Minimum	Nominal	Maximum	Minimum			Nominal	Maximum	Minimum
1	3 1/2	3 17/32	3 15/32	2 1/2	2 1/2	2 15/32	3/8	1 13/16	1 27/32	1 13/16	11/32	11/32	5/16	11/32	1/2	13/16	27/32	25/32
3/4	2 3/4	2 25/32	2 23/32	1 7/8	1 7/8	1 27/32	5/16	1 13/32	1 7/16	1 13/32	9/32	9/32	1/4	15/64	1/2	13/16	27/32	25/32
5/8	2 1/2	2 17/32	2 15/32	1 1/2	1 1/2	1 15/32	1/4	1 5/32	1 3/16	1 5/32	7/32	7/32	3/16	11/64	1/2	13/16	27/32	25/32

[7] Draw-in bolt is shown in the cut at the top of the second column on p. 713 and the dimensions are given in Table 3.

ENGINEERS AND MACHINE-TOOL EXHIBITS

Chairman Bouton of Production Advisory Committee Outlines Latter's Advantages

In connection with the plans that are being formulated by the Society for its Annual Production Meeting in Cleveland and Detroit next September that will be held simultaneously with exhibits of machine-tools and steel-treating equipment, it is appropriate at this time to point out the advantages to the production engineers in automotive plants of attending the meeting of the Society and visiting the exhibits. These are

(1) The production engineer has the opportunity to study the latest type of practically all classes of machine-tools that are used in the metal-working industries and their operation

(2) He has the opportunity of directly comparing competing lines of equipment, studying their particular features, asking questions of their representatives, and of forming definite opinions as to the machines that would best meet the needs of his particular plant

(3) He does not have to rely on the salesman's description of the machine or on catalogs or other indirect sources of information but sees the machine in which he is most interested performing on regular production work as it would in his own plant

(4) There is brought to his attention the application of other types of machine that perhaps he has not known of but that are suitable to his particular line of manufacture

(5) His knowledge of machine-tools in general is broadened, particularly as to their design, adaptability, future possibilities, and special features in the way of auxiliary equipment that might aid him materially in his own line of work

(6) In addition to the foregoing advantages it provides a place for meeting other production engineers and discussing the various merits of each type of machine and its application to their own lines of production. Some of the best information that can be gathered by a production man can be derived from the opinions of others having similar experience, and in forming his own opinions to guide him in the selection or future recommendation of machine-tool equipment

(7) The production engineer can and should attend the meetings of engineering societies that are frequently held simultaneously with exhibits and at which papers on engineering and manufacturing subjects are read and freely discussed. This affords him an excellent opportunity of forming wide circles of acquaintance among the best men in similar lines of work and taking an active part in the discussion of the papers that deal with the most modern and improved methods in manufacturing and afford valuable information which cannot be obtained in other ways

(8) The production man who attends such exhibits and engineering society meetings has an exceptional opportunity to form or receive ideas, the application of which to his own problems would effect savings in production cost far beyond the expense of his attendance

RESEARCH IN PRODUCTION ENGINEERING

Meeting at French Lick Springs Discusses Programs of Several Subjects

There has been a well-defined belief for some time among production engineers in the automotive industry that many benefits will be derived from a well-organized program of technical research relating to machinery, methods, fixture equipment, and tools and materials that are used in manufacturing motor-vehicles and their components. Accordingly the members of the Production Advisory Committee of the Society were recently canvassed for suggestions as to definite subjects that could be referred to the Research De-

(*Concluded on p. 824*)

STANDARDIZATION ACTIVITIES

The work of the Divisions and Subdivisions of the S.A.E. Standards Committee and other standards activities are reviewed herein

BALL-BEARING COMMITTEE MEETS

Proposal for Conference To Further International Standardization Considered

After negotiating for several years with the European countries, principally Sweden, Germany, Switzerland, and England, good progress has been made toward the accomplishment of the international standardization of ball-bearings. The fact that the sizes and dimensions of ball-bearings used in America were founded on and have practically followed the original metric sizes and dimensions of bearings made in Europe, has made it possible very largely for the American industries to negotiate with those in Europe toward the formulating and adopting of definite international standards for ball-bearings. The American industrial interests in this connection have functioned through the Sectional Committee on the standardization of ball-bearings that was organized and sponsored by this Society and the American Society of Mechanical Engineers under the procedure of the American Engineering Standards Committee. Agreement has been reached on all the dimensions for the light, medium and heavy series of annular ball-bearings with the exception of tolerances on diameters, which, however, extend in the same direction from the nominal diameters and do not differ in value sufficiently to interfere with the interchangeability of ball-bearings internationally. A table of adapter-sleeve bearing sizes, sleeve tapers and shaft diameters in American, English and equivalent metric sizes has been prepared by the Sectional Committee. The most recent development is the proposal of tables for the medium and heavy series single-direction flat-face type, metric thrust ball-bearings which conform in diameters and heights to those included in the latest proposal that seems to be most generally favored in the European countries.

An invitation from the European countries has been received by the Sectional Committee to send delegates to an international conference on ball-bearing standardization at Stockholm in August which has been proposed by the European national standardizing bodies. A meeting of the Sectional Committee was held in New York City on May 17 to take action on this invitation that resulted in the decision not to incur the expense and time necessary of sending delegates to the conference. It was decided, however, to transmit a statement of the Sectional Committee's favorable attitude toward international standardization of ball-bearings and its attitude with regard to the proposed tables that have been favorably considered so far by the several countries. It was also felt that if possible to do so it would be desirable to arrange to present this statement through a personal representative in Europe who is conversant with the ball-bearing standardization activities.

A draft of the complete report of the Sectional Committee was reviewed and brought uptodate preparatory to having it set in type for publication. It was decided, however, to delay final approval by the Committee of the several proposals comprising the report until the Committee learns what transpires at the proposed international conference referred to above. The complete report of the Committee will probably be printed in an early issue of THE JOURNAL and after its approval by the Sectional Committee will be submitted to the sponsors. It will then be assigned to the Ball and Roller Bearings Division of the Standards Committee for approval in accordance with regular S.A.E. Standards procedure as the report for American Standard. The final step in its acceptance will be submission to and approval by the American Engineering Standards Committee insofar as the organization and procedure of the Sectional Committee is concerned.

The action taken at the meeting of the Committee is subject to approval by ballot of the Committee inasmuch as there was not a quorum present. Those in attendance were: H. E. Brunner, of the S.K.F. Industries, Inc., chairman protem; G. R. Bott, of the Norma-Hoffmann Bearings Corporation; F. L. Brown, of the White Motor Co.; C. A. Call, of the Rollway Bearing Co., Inc.; E. R. Carter, Jr., of the Fafnir Bearing Co.; T. C. Delaval-Crow, of the New Departure Mfg. Co.; L. C. Fisk, of the Hyatt Roller Bearing Co.; G. E. Greenleaf, of the Niles-Bement-Pond Co.; H. N. Parsons, of the Strom Bearings Co., and R. S. Burnett, manager of the Standards Department and secretary of the Committee.

GEAR-STEEL SPECIFICATIONS PROPOSED

Tentative Report Released by Sectional Committee for Review by Industry

The first tentative report of Subcommittee No. 8 on Gear Materials, organized under the Sectional Committee on the Standardization of Gears that is sponsored by the American Gear Manufacturers' Association and the American Society of Mechanical Engineers under the procedure of the American Engineering Standards Committee, has just been released for comment. The Sectional Committee was organized by its sponsors in June, 1921. The report that is printed below in full is one of a number that the Subcommittee will issue, each relating to a particular type of steel for gears. The reports will be issued separately as they are drafted by the Subcommittee, but will not be referred to the Sectional Committee for its approval until all of the Subcommittee's reports shall have been circularized and their acceptability by industry indicated. In submitting them to the Sectional Committee later on, the individual reports dealing with various types of steel for gears will be printed into a single report on Gear Materials.

Although some or all of the steels included in the specifications that will eventually be issued may be applicable to gears used in motor-vehicles, the scope of the Sectional Committee's project relates to the standardization of gears for general mechanical construction, particularly for such gears as are ordinarily carried in stock by the gear manufacturers. It is not the intention of the Sectional Committee to have the standards when formulated apply to gears that are customarily designed to meet the particular conditions of individual makes of vehicle, unless the designers of such vehicles choose to use them. The reasons for this are obvious to anyone familiar with the designing and making of motor-vehicle gears.

Comments or constructive criticisms and suggestions regarding the following report are desired for the guidance of the Subcommittee in giving further consideration to the report, and should be sent to the Society's offices in New York City.

SPECIFICATIONS FOR FORGED AND ROLLED CARBON STEEL FOR GEARS

Material Covered.—This specification covers steel for gears in three groups, according to heat treatment, as follows: (*a*) case-hardened gears; (*b*) unhardened

gears, not heat-treated after machining; and (*c*) hardened and tempered gears.

Basis of Purchase.—Forged or rolled gear steels shall be purchased on the basis of the requirements as to chemical composition specified in the following table. Requirements as to physical properties have been omitted, but when they are called for the requirements as to carbon shall be omitted.

Use	Case-Hardened	Untreated	Hardened
Class	*C*	*N*	*H*
Carbon, per cent	0.150-0.250	0.250-0.500 0.400-0.500	0.400-0.500
Manganese, per cent	0.400-0.600	0.500-0.800 0.400-0.600	0.400-0.600
Phosphorus, per cent[1]	0.045	0.045	0.045
Sulphur, per cent[1]	0.050	0.050	0.050

[1]Phosphorus and sulphur percentages are maximum.

MANUFACTURE

Process.—The steels may be made by either or both the open hearth and electric furnace processes.

Discard.—A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

CHEMICAL COMPOSITION

Derivation.—Class C is S.A.E. Steel 1020 excluding the lower 10 points of manganese range. Class N is S.A.E. Steels 1030, 1035, 1040, and 1045, along with the 0.45 per cent of carbon steel specified in class H. Class H is similar to S.A.E. Steel 1045 but with a modified manganese range.

LADLE ANALYSIS

An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of the elements specified. This analysis shall be made from drillings taken at least ¼ in. beneath the surface of a test ingot obtained during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements specified.

CHECK ANALYSIS

Analysis may be made by the purchaser from one or more bars or forgings representing each melt. The chemical composition thus determined shall conform to the requirements specified above. Drillings for analysis shall be taken at any point not closer to the center than midway between the center and the surface, but not within ¼ in. of the surface of the bar or forging.

FINISH

The material shall be free from injurious defects and shall have a workmanlike finish. Cold-finished bars shall have a bright smooth surface.

MARKING

The melt number shall be legibly stamped on each bar or forging 4 in. or over in thickness and on those of smaller section when so specified. The number stamped on gear blanks shall be placed on the web or in such a position that it will not be obliterated in machining operations.

INSPECTION

The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

REJECTION

(*a*) Unless otherwise specified, any rejection based on tests made in accordance with this specification shall be reported within 10 working days from the receipt of samples. (*b*) Material which shows injurious defects while being finished by the purchaser will be rejected, and the manufacturer shall be notified.

REHEARING

Samples tested in accordance with this specification which represent rejected material, shall be preserved for 2 weeks from date of test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

SAFETY CODE FOR RUBBER MACHINERY

Report Approved Affecting Operation Hazards for Rubber Mills and Calenders

About 4 years ago a Sectional Committee was organized under the procedure of the American Engineering Standards Committee to formulate a safety code for rubber machinery. The sponsors for the Committee are the National Safety Council and the International Association of Industrial Accident Boards and Commissions. The American Engineering Standards Committee at its meeting in March of this year finally approved the report of the Committee relating to the operation hazards of rubber mills and calenders. The code covers the mechanical hazards encountered in the manufacture of rubberized fabrics, tires, hose, molded rubber-goods, belting, reclaimed rubber and many other products; together with calenders, spreaders, coaters and dryers, and other machinery used in the manufacturing of rubber goods, except that for spinning and weaving fabrics. Neither does it apply to the internal-type mixers, washers or masticators except insofar as there may be running rollers attached or used in connection with them. The report relates to new and existing installations with respect to sources of both natural and artificial light, power drives and guards for them and switches and other electrical apparatus. Rules are also provided for the minimum height to the top of the front roller above the working-floor level, the providing of safety-trip controls and quick-stopping facilities.

Maximum stopping-distances for individually driven mills and mills driven in groups are given under a classification according to the diameter of the front roller and when running empty at any speed. The report states that there is a wide variation in the distance that rolls will travel after the safety trip has been operated in present mills and that the quick stopping of mills and calenders is a very important factor in accident prevention. It was pointed out that some form of braking device is absolutely necessary and that to have a standard condition for testing and comparison of performance, it is necessary to make tests for quick stopping with all the equipment running idle.

Internal Wheel-Brakes for High-Speed Heavy Vehicles

By H. D. CHURCH[1]

SEMI-ANNUAL MEETING PAPER *Illustrated with* DRAWINGS AND PHOTOGRAPHS

ABSTRACT

The paper deals primarily with internal wheel-brakes for trucks and motorcoaches, but passenger-car brakes with similar characteristics are considered possible. A simple two-shoe internal-expanding type developed mainly by empirical methods is found to be the most practical solution in spite of relatively low circumferential contact. Self-organization is necessary to reduce driver effort with normal pedal-travel. The factors controlling self-energization are explained in detail, and the effect of difference in the coefficient of friction of brake-linings is noted.

Distortion of brake-drum and brake-shoes must be limited by a drum of heavy section and by extremely rigid shoes. Rotation of cam with respect to self-energizing shoe should tend to deflect the toe of shoe away from brake-drum surface. A floating-cam is necessary to balance unequal wear on shoes and assure adequate braking with normal pedal-pressure.

High-grade cast-iron brake-drums have been found to be generally more effective than steel drums with fabric-lined brakes.

Air-brakes of the same general design, with metal-to-metal surfaces, are used in all four wheels of the six-cylinder motorcoach, but the floating-cam construction is unnecessary in this case. The metal-to-metal combination of high-carbon drums with low-carbon shoes is found to be effective under all weather-conditions, and is regarded as the solution of the problem of brakes with adequate life and effective heat-dissipation for heavy, high-speed motorcoaches.

THIS paper deals primarily with the development of internal wheel-brakes for motor-trucks and high-speed motorcoaches. As a loaded 21-passenger motorcoach weighs 13,000-lb. maximum, and a 29-passenger motorcoach weighs 18,000-lb. maximum, the problem of obtaining satisfactory wheel-brakes is a serious one from the standpoint of effectiveness, life, and heat dissipation. It is probable that any type of brake that is satisfactory on a motorcoach would be quite satisfactory on passenger-cars, where the service conditions are much less severe.

During our development work on internal brakes we have never been able to obtain a complete reconciliation between theory and practice. Probably the theories we used were wrong. Consequently, the brakes we are now using represent an empirical development, and I can do no more than to point out the features which have made the design practicable, as well as some of the pitfalls to be avoided in the design of brakes of this type.

TWO-SHOE INTERNAL BRAKE PREFERRED

Early in our development work, after various experiments with expanding-band and multiple-shoe brakes, we decided that the simple two-shoe internal-expanding combination represented the most practical solution of the problem, therefore we concentrated on this type. We were fully aware that this type of brake has certain drawbacks, such as a relatively low percentage of 360 deg. of lining contact, but in our opinion the disadvantages are relatively unimportant among considerations affecting the final results that are attainable.

It is necessary to keep the body and chassis of a motorcoach as low as possible, and for this reason the use of 20-in. rims is desirable. This limits the diameter of brake-drum that can be used, as the inner of the dual rear-tires overlaps a large portion of the outside diameter of the brake-drum. This condition makes the braking problem more difficult in two ways:

(1) By limiting the diameter of the drum that can be used
(2) By masking the brake-drum so that the ability of the drum to dissipate heat is materially reduced

On heavy high-speed vehicles under these conditions it is obvious that if an approximately normal pedal-travel is to be maintained, some means must be provided to augment the effort of which the driver is capable. Also from the viewpoint of first cost and weight it is desirable to eliminate the use of any servo mechanism, using this term in the commonly understood sense of a means external to the brake proper, for stepping up the force applied by the driver to the foot-brake pedal.

It is a well-known fact that in a two-shoe brake of the internal-expanding type, the shoe upon which the direction of rotation of the drum runs from the cam end toward the hinge end, possesses self-energization characteristics. A dimension drawing of a brake of this type is shown in Fig. 1, and Fig. 2 is a photograph of the complete brake assembly.

GOALS OF THE DESIGNER

The objects to be attained in connection with the design of a brake of this type can be briefly stated as follows:

(1) The maximum degree of self-energization that will not "grab" or give roughness when using a brake-lining having the highest coefficient of friction of any that is obtainable on the open market, in order to obtain sufficient self-energization with the lowest coefficient of friction to be found with any brake-lining that is likely to be obtained
(2) Ample braking effect and ability to hold equally well with either direction of drum rotation
(3) Uniformity of brake action throughout the life of the brake-lining
(4) Satisfactory life of both brake-linings and drums

CONTROLLING SELF-ENERGIZATION

The factors affecting the self-energization characteristics of the brake shown in Fig. 1 are as follows, no

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attempt being made to list them in the order of relative importance:

(1) The coefficient of friction of the lining. It is probable that the coefficient of friction of the brake-drum itself also has its effect, but we disregarded this factor as there is little difference in coefficients of friction of the materials suitable for brakê-drums
(2) The angle a, having its vertex at the geometrical center of the brake-drum and formed by lines passing through the center of the cam and the toe end of the lining. Within certain limits the greater the angle a the less is the degree of self-energization, and vice-versa. Our experience indicates that the brake is very sensitive to variations in this angle
(3) The corresponding angle b, at the hinge end of the shoe. Variations in angle b are of much less importance than variations in angle a
(4) The ratio between the radial distances from the brake-drum center to the inner surface of the brake-drum and to the hinge-pin center, 6⅛ to 8⅝ in this case. This ratio, like angle a, has to be held within close limits because it has a major effect on the degree of self-energization
(5) The resistance of the brake-drum to distortion. With a high degree of self-energization, the tendency to spring the brake-drum out of round is very great
(6) The resistance of the brake-shoes to distortion, as a result of either force or heat

After a great deal of cutting and trying with these six variables we arrived at the combination shown in Fig. 1.

It will be noticed that the brake-drum, shown in the upper right view of Fig. 1, is of somewhat heavy section and reinforced by circumferential cooling-ribs, also that the brake-shoes are of extremely rigid design.

Guarding Against Grabbing

In order to take care of manufacturing variations within normal commercial limits it has been found necessary to skive off the toe end of the shoe surface as shown in the enlarged lower right view of Fig. 1. This is done to make certain that, with a new drum, new shoes, and new lining, initial lining contact cannot start clear out at the toe end of the lining. If this occurs the degree of self-energization is very high, causing distortion of both drum and shoe, and in some cases is great enough to lock the rear wheels.

With the degree of self-energization used, an important consideration is the direction of rotation of the actuating-cam with respect to the shoe ends. The pressure between the cam and the ends of the shoes is fairly high, and as the cam surface must slide on the hardened part at the end of the shoe, the relative direction of rotation of brake-drum and camshaft should be as indicated in Fig. 1. This assures that the frictional drag between the cam and the self-energizing shoe tends to deflect the toe end of this shoe away from the brake-drum surface instead of toward it. Reversal of the direction of cam rotation will in some cases make the difference between a "grabbing" brake and smooth brake-action.

In a brake of this type, the self-energizing shoe does considerably more work than the other shoe. This means that the lining of the self-energizing shoe wears more rapidly than the lining of the other, and unless some provision is made to compensate for this difference in wear the brake will become much less effective as the lining of the self-energizing shoe becomes worn. In order to overcome this condition by automatic means the cam is mounted on a floating bell-crank, one end of which carries the camshaft, while to the other end is fitted a frictional device, as illustrated in Fig. 3. In operation,

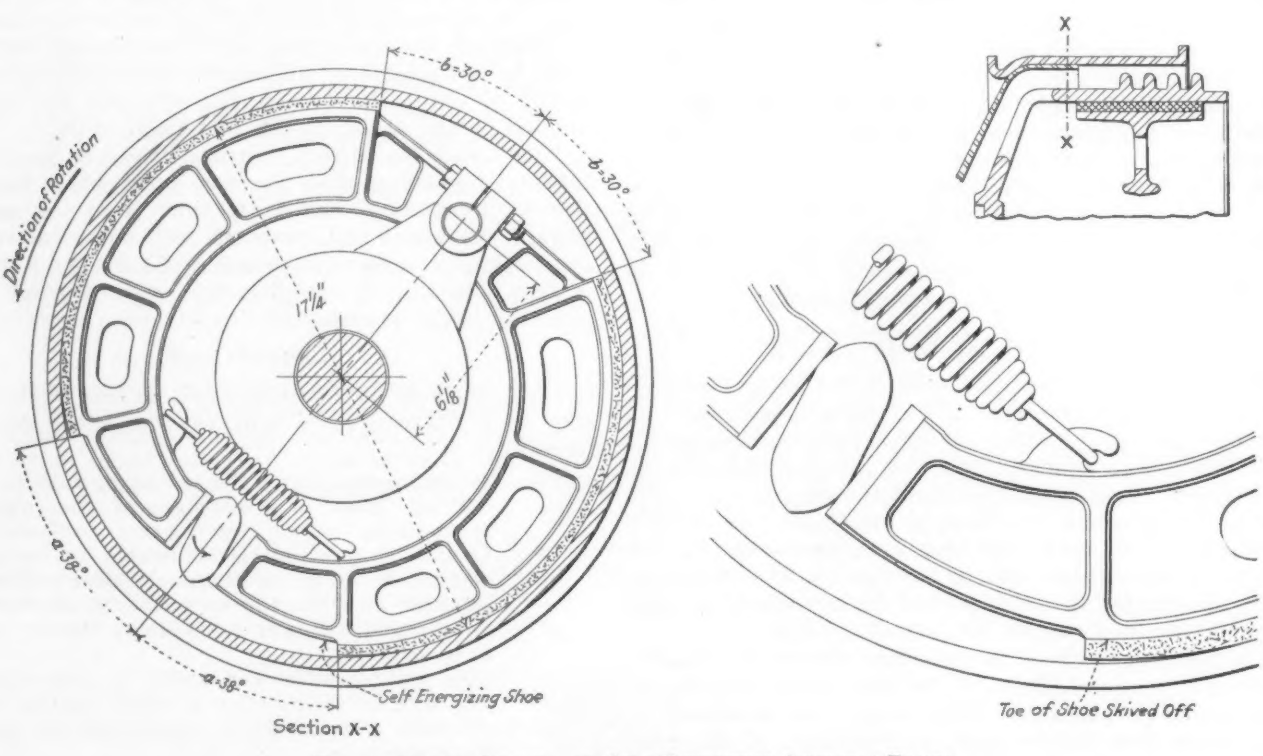

Fig. 1—Design Details of Self-Energizing Internal-Brake

Small Variations in the Angle a Affect Appreciably the Sensitivity of the Brake. Variations in Angle b Have Slight Effect. The Location of the Hinge-Pin Center Has Important Influence on Self-Energization. Cam Rotation as Indicated Tends To Deflect the Toe End of Self-Energizing Shoe Away from the Drum. The Section at the Upper Right Shows the Openings in the Drum and the Clearance between Drum and Rim. Toe End of Brake-Shoe Must Be Skived Off as Shown in the Enlarged Lower View To Prevent Grabbing of the Lining when New. Otherwise Production Variations May Cause Initial Contact at This Point and Locking of the Brakes May Result

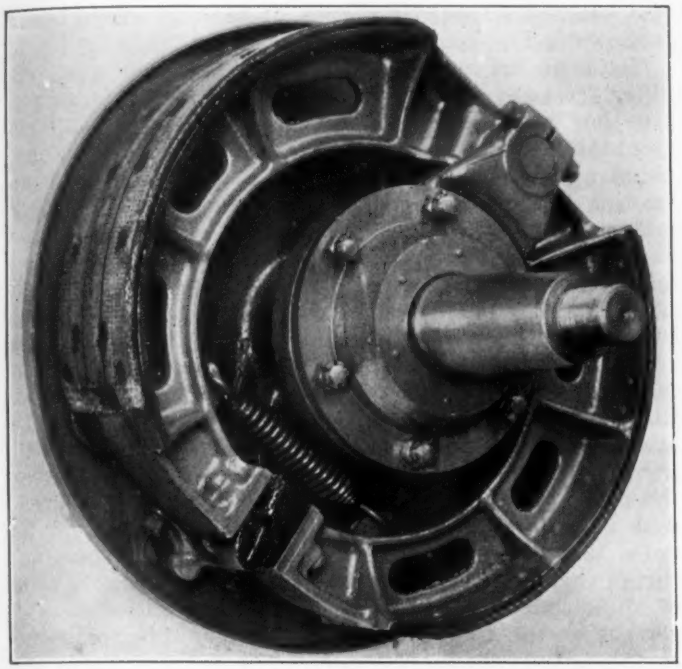

Fig. 2—View of Rear-Wheel Brake-Shoe Assembly
Note Heavily Ribbed Brake-Shoes Assuring the Extreme Rigidity Necessary. Cap-Screws of Floating-Cam Bracket Appear below the Cam. The Pivot Is Concealed behind the Retracting Spring

the floating bell-crank simply permits the cam to change its position to compensate for difference in wear of the linings of the two shoes. The frictional device is made strong enough so that with the brakes released it will prevent the whole assembly from dropping into contact with the drum under the influence of road shocks. It must still be sufficiently free so that when the brake is applied the bell-crank can move and let the two shoes adjust themselves according to the relative lining-wear.

Actual Dimensions Given

The vital dimensions and angles of this brake given in Fig. 1 show the actual construction as used on our 16 to 21-passenger motorcoaches. The width of lining is 4 in. The rear tires are 34 x 7.50-in., low-pressure, with a loaded rolling-radius of 16.76-in. The allowable gross weight of this vehicle is 13,000 lb., and it is capable of road speeds of over 50 m.p.h.

The mechanical advantage between the pad of the foot-brake pedal and the point of contact of the brake-cam with the brake-shoes is 47 to 1. With this ratio the pedal pressure required to slide the rear wheels is not inordinate, but because of the frequent stops made by the usual motorcoach, it was considered advisable on this model to materially lower the required pedal-pressure by the use of a vacuum booster-cylinder in the line. This is a refinement rather than a necessity.

In service, the brake is equally effective in either direction. Starting cold, repeated applications will cause the initial pedal-travel to increase somewhat, because the drum expands in advance of the shoes. This is due to the heat-insulating qualities of the conventional brake-lining. As the shoes warm up, the pedal travel returns to normal. We find that one lining of the upper or non-self-energizing shoe will usually out-wear two linings on the lower shoe. Under what might be termed average road conditions, such as runs between Cleveland and Buffalo or Columbus and Cincinnati, our customers obtain approximately 20,000 miles of service before it is necessary to reline the lower shoes. During our own original road-test work we averaged from 23,000 to 24,000 miles with one brake application every 9/10's of a mile before relining the lower shoes.

Cast-Iron Brake-Drums

An interesting fact in connection with the life of the brake-linings is that we have for some time been using with great success a somewhat unconventional material for the brake-drums, namely, a high-grade cast iron. This material was decided upon after a long period of experimentation with steel drums varying in carbon content, some running as high as 0.70 per cent, with various malleable irons and with special alloy combinations. Contrary to our early expectations, the cast iron is less affected by dirt than are any of the other materials we experimented with. It resists wear to an astonishing degree, and in service acquires a mirror polish. There is no tendency for small particles of the brake-drum surface to be "picked off" and imbedded in the lining, thus scoring the drum surface.

While cast iron presumably has a lower coefficient of friction than any of the other materials tried, it has made no appreciable difference in brake performance. No comparative tests for coefficients of friction have been made.

The same type and size of brake is used without a vacuum booster on our 2-ton truck, which has an allowable gross weight of 13,000 lb. With the same drum-diameter, but a wider face, it is used on our 2½-ton truck, having a gross-weight allowance of 17,000 lb. In this application the mechanical advantage between the pedal-pad and the point of contact of the brake-cam with the brake-shoes is 51 to 1, giving a normal pedal-travel with sufficient freedom from brake adjustment. The rear tires are either 36 x 8-in. single solids, or 34 x 7-in. dual high-pressure pneumatics. The muscular force required at the pedal of this 2½-ton truck is as high as we feel can safely be depended on. In order to handle greater gross-weights it will be necessary to add some form of servo mechanism.

Design of Brake Connections Important

On any vehicle where high braking-effect is required, it is most important that two other points in addition to the design of the brake itself be given careful attention. All the connections between the brake-pedal and

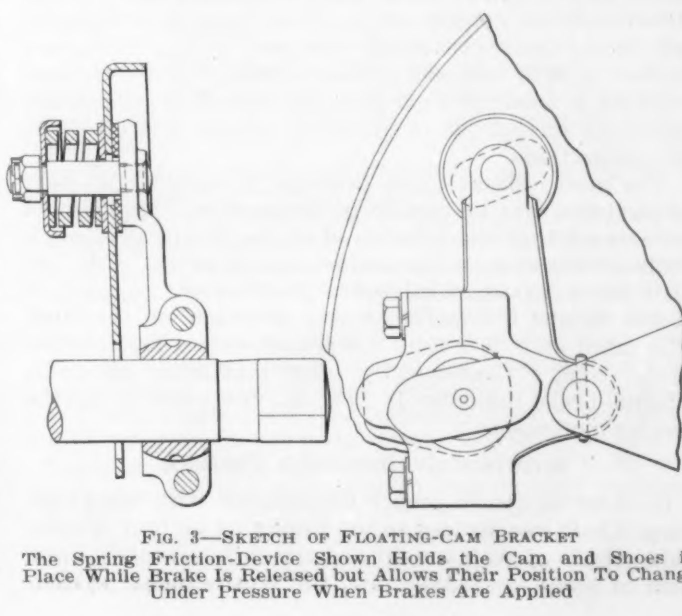

Fig. 3—Sketch of Floating-Cam Bracket
The Spring Friction-Device Shown Holds the Cam and Shoes in Place While Brake Is Released but Allows Their Position To Change Under Pressure When Brakes Are Applied

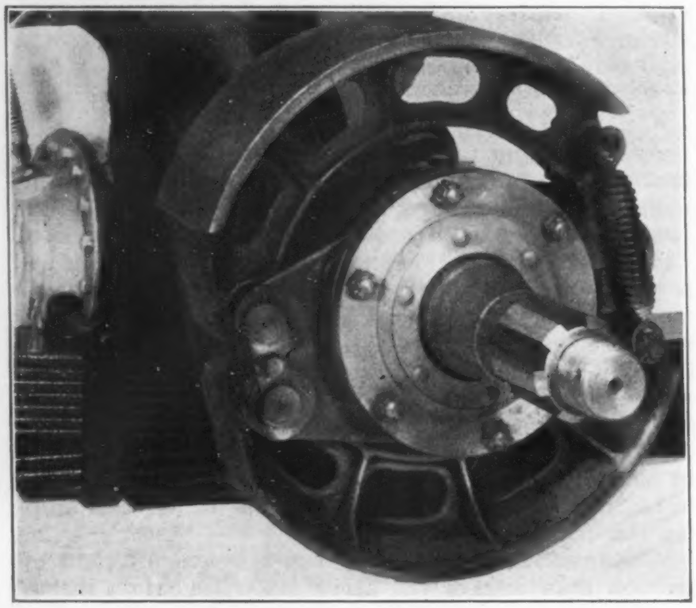

FIG. 4—VIEW OF AIR-OPERATED REAR-WHEEL BRAKE-SHOE ASSEMBLY
This Brake Is Used on Rear Wheels of 25 to 29-Passenger Motorcoach. It Has 5-In. Wide "Throw-Away" Type Metal Shoes without Lining or Dust-Shields. Note Air Diaphragm at the Left

the working surface of the brake-cams should be made sufficiently stiff so that under maximum application of pressure all deflections are kept down to a reasonable amount in order to avoid unnecessary loss of effective travel. This applies to deflections both in bending and in torsion. Torsional rigidity is particularly important in the intermediate brake-shaft extending across the frame when the pull from the pedal is applied at the left and the pull to the brakes at the two ends. If this shaft is too light the resulting braking-effect, even with an equalizer, is greater on the left brake than on the right.

The other point to be watched is the question of proper geometry of the brake linkages between the frame and the levers on the rear axle. These should be worked out so that for the full range of spring travel there is the minimum effect either on the brakes or the brake-pedal. Otherwise effective pedal-travel is again lost.

The industry has for years been aware of both the above points, but in many instances they have not been given sufficient consideration. They must be watched in any brake design to obtain the best results, and many brakes on both cars and trucks of today's production are working at subnormal efficiency because of either a flimsy operating mechanism or improper geometrical-layout of the connections.

The most difficult brake problem of any that we have encountered was on our 25 to 29-passenger, six-cylinder motorcoach that was announced at the American Electric Railway Association Convention last October. This vehicle has a maximum allowable gross-weight capacity of 18,000 lb. and is capable of over 60 m.p.h. on the road. It is fitted with 38 x 9-in. low-pressure tires that require 20-in. rims. Consequently, the maximum allowable internal-brake diameter is 17¼ in., the same as on the smaller motorcoach.

SOLUTION OF DIFFICULT PROBLEM

In order to obtain proper deceleration with maximum brake life it was decided to use brakes on all four wheels. On a vehicle of such weight and speed this involves some form of servo mechanism, and the Westinghouse system was adopted. The construction of the rear-wheel brake is shown in Fig. 4, and of the front-wheel brake in Fig. 6.

These brakes are of the internal-expanding type, but differ from those used on the small coach in that advantage has been taken of the greater pressure available from the Westinghouse system to eliminate brake-linings, using metal-to-metal braking surfaces. Except that no friction linings are used, the various factors affecting self-energization in these brakes are exactly the same as in the smaller motorcoach, but owing to the added application force made possible by the use of compressed air there is no necessity to add a self-centering feature by floating the cam. The application force due to the compressed air is sufficient to give proper braking even without using the self-energizing feature of the shoe. Consequently when the self-energizing shoe is worn to such an extent that it has less positive contact with the drum it is only necessary for the operator to depress the brake-pedal further, thus applying higher air pressure at the brake camshaft diaphragm. It should be noted that, in order to compensate for normal manufacturing variations and to prevent "grabbing," the toe ends of all shoes are skived off to prevent high-pressure toe-contact at the time of initial assembly, this being the same practice mentioned before. The brake surfaces are metal-to-metal, no liners being used either in the drums or on the shoes. Both drums and shoes are of cast steel, the drums having a high carbon-content and the shoes a low carbon-content. This combination of metals, together with the degree of self-energization obtained, gives very smooth operation. The drums and shoes are of what we term the "throw-away type," so-called because they are used until worn out and then are scrapped.

PROVISION FOR DISSIPATION OF HEAT

One of the most important features of this brake is its ability adequately to dissipate heat. As no lining or liners are used, the brake-shoes as well as the brake-drums are available as heat reservoirs and radiators.

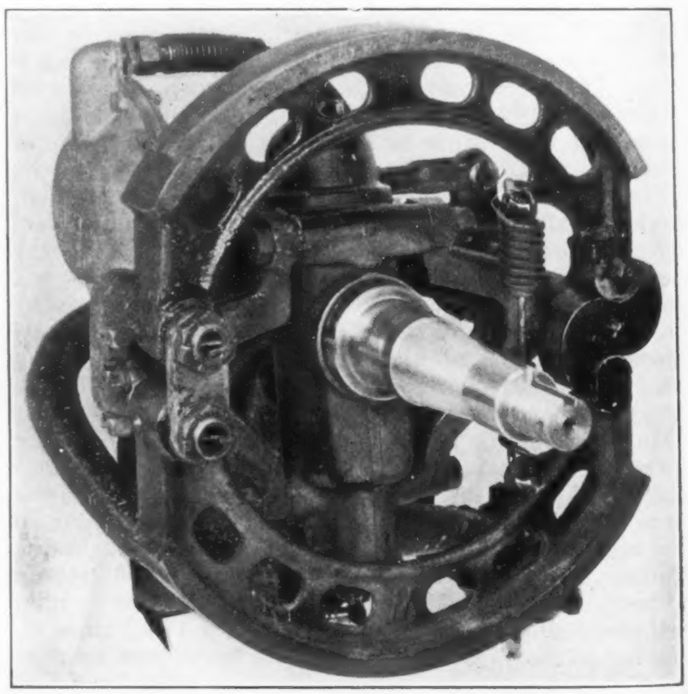

FIG. 5—VIEW OF AIR-OPERATED FRONT-WHEEL BRAKE-SHOE ASSEMBLY
This Is Used on the Same Motorcoach as Brake Shown in Fig. 4. The "Throw-Away" Type Shoes Are 2 In. Wide

In order to obtain the maximum cooling effect no shields are used across the inner face of the drum, so that there is a free circulation of air throughout the entire assembly. With this type of brake the brake-drums have cast openings, as shown in the upper right view of Fig. 1, to allow any accumulation of dirt or metal chips to escape from the inside of the drum. The use of these openings has materially helped in the elimination of drum and shoe cutting. As the action of this brake is not affected by any normal amount of water such as is encountered in wet-weather driving over improved roads the elimination of drum-shields is perfectly permissible. Grease and oil in moderate amounts have no appreciable effect on the braking.

With all the brake constructions described above the hand-brake is mounted on the propeller-shaft, back of the transmission.

After almost 2 years' experience with metal-to-metal internal-expanding brakes, I am very strongly in favor of that construction. There is only one drawback from a passenger-car viewpoint, and that is the slight noise made by the braking surfaces during operation. So far as that goes, I hear the friction-fabric faced external-brakes on many of the new cars making a great deal more noise than do these metal-to-metal internal-expanding brakes, and the noise is of a more unpleasant character, due to its pitch.

The fact that the metal-to-metal brakes are so constant in action throughout their life, irrespective of atmospheric or road conditions, results in the safest braking we know today. The internal-expanding type, properly designed, makes it possible to use the maximum available diameter inside a given rim, and if the metal-to-metal combination can be used there is the added benefit of a well-cooled brake for driving at high speeds or in mountainous country.

RAIL AND RUBBER

ON at least 25,000 miles of line, the 10 per cent of the American rail system that carries half the freight traffic, the steam locomotive is slated for the discard to be succeeded by the electric motor. The crosstie will be succeeded by a permanent concrete-base gripping the rails, and a speed of 200 m.p.h. probably will be commonplace. No steam locomotive of the first class has ever yet been let out and given a chance to do its stuff, simply because no existing railroad track could hold it. On many thousands of miles of railroad line three or four times the present value of the roadbed and fixed equipment will be expended in electrification, permanent roadbeds and the elimination of grades and curves.

As something like 3,500,000 people are employed directly or indirectly in the motor-vehicle industry, and as that many workers represent 10 per cent of the population, it is equally apparent that 10 per cent of general railroad traffic is now bound up with the motor-vehicle industry. Turning the thing around, we should probably find that, directly and indirectly, the railroads give employment to more than 3,000,000 men supporting 10 per cent of the population of this Country. Therefore about 10 per cent of all automobile business is from the railroads.

We have, then, two giant transportation enterprises, each supporting 10 per cent of the American people and serving them all and each other. An interesting fact is that the value of the two transportation plants is approximately equal and that together they constitute about 20 per cent of our National wealth.

The approximate inventory is as follows:

Miles of railroad, 250,000; locomotives, 68,000; freight-cars, 2,500,000; passenger-cars, 57,000; value, $25,000,000,000.

Miles of improved highway, 500,000; motor-cars and trucks, 23,000,000; value, $25,000,000,000.

The annual transportation bill of the United States appears to be about $13,000,000,000, split about equally between the two systems. An American railroad moves 1 ton of freight one mile for 1.1 cents.

Basing our estimate on the number of passenger automobiles and motorcoaches in the Country, and the average annual mileage of an automobile, we are making a reasonable guess when we put the passenger-miles done last year by automobiles at 240,000,000,000. Railroads probably did not exceed a mere 35,000,000,000 passenger-miles last year, and the electric railways do about 40,000,000,000 per year on city streets and the interurban lines. The automobile as a passenger carrier is ahead of the steam and electric roads by a majority of more than three to one. Most of this automobile traveling is new movement by the people, and half of it is on city streets only. The electric railways are holding their own in total passenger traffic, although they are not gaining except in some big cities.

Figures show steam railroads have lost, too. Travel in day coaches has declined 22 per cent since 1921, but travel in Pullmans has increased 22 per cent in the same period. The loss of passengers by the railroads has been more significant numerically than financially, because the class of passenger traffic that pays them best is gaining. Short-haul passenger traffic, like short-haul freight-traffic, is rarely as profitable as long-haul business. Much railroad short-haul business, both passenger and freight, has been done at a loss. In freight movement, the railroads' gains more than keep step with the growth of the Country in population and prosperity. They are carrying for every person in the Country 25 per cent more freight than they were carrying 5 years ago. Last year they hauled nearly 8,000,000 more carloads than in the last "boom" year of war-bred prosperity.

For the last year for which figures are now complete, railroad freight performance amounted to 414,000,000,000 ton-miles. For the same year the closest and most reliable estimate of freight movement by truck was 16,000,000,000 ton-miles. Not more than half of this was on rural highways, and movement by truck on city streets represents no loss to railroads. On highways it may or may not. A large part of rural highway freight movement by truck is feeder traffic to railroads. Not much more than 15 per cent of rural highway truck traffic moves more than 40 miles. The average ton of freight goes 178 miles.

The cost of transportation is very largely in loading and unloading, and wherever a direct truck-haul eliminates a rehandling within practical truck radius, the truck will get the business. The railroad in such cases has no more chance against the truck than the steamboat had against the railroad. But on the big stuff the truck has no more chance against a railroad than a railroad has today against a Lake ore boat from Duluth to Gary. When the truck takes a short haul from a railroad, it very frequently takes a loss from the road. Stopping trains costs money. Merely bringing a 600-ton freight train to a halt costs from $1.30 to $1.50, to say nothing of the cost of delay and switching after the train is stopped.

America needs more transportation of all kinds, and will get it; on water, rails, rubber, and in the air.—Harper Leech in *Liberty*.

Notes on Valve-Spring Surge

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Semi-Annual Meeting Paper *Illustrated with* Photographs

ABSTRACT

A STUDY of the influence of vibration on valve-springs reveals two possible ways in which a valve-spring can vibrate: First, when the frequency of the forced vibration is low, the force tending to vibrate the spring is small, due to the comparatively small centrifugal effect of the valve-operating cam, and the time between applications of the force is long enough to permit the vibrations set up in the spring to die out between successive applications of the force, the spring vibrates as a part of the entire vibrating system. Second, if the forced vibration is of a rather high frequency and is of such a value that it is an arithmetical factor of the natural frequency of the spring, a condition of resonance may be set up whereby the spring vibrates in itself at its own frequency.

An analysis of surge effected with the aid of a super-speed motion-picture film and the vibroscope, which were used in conjunction with a valve-gear testing-machine, reveals that, when the spring is vibrating in its own period, at a given instant, certain adjacent coils may be spread apart beyond their normal position for an equivalent static compression and that, an instant later, the condition of these coils may be exactly reversed so far as deflection is concerned.

The abnormal compression of the coils at one instant and abnormal opening of the same coils at the very next instant cause the existence of a stress and a stress range that are much greater than those calculated by conventional formulas. Furthermore, the stress range is passed through in a time equivalent to that required for the completion of one wave of the natural period of the spring. This time factor, combined with the stress conditions existing, tends to accelerate greatly the fatigue of the valve-spring. Accordingly, the condition described is a very prolific cause of valve-spring failure.

WHEN automotive valve-springs fail after comparatively short service it is common practice to investigate the failure as being due to one or more of three causes: (*a*) defective wire, (*b*) improper heat-treatment or (*c*) faulty design. Unfortunately, the trouble cannot always be traced back to one of these causes, hence solution of the problem is not always simple. Investigations of failures often reveal that the wire was free from defects, that the heat-treatment was correct, and that the stress and stress range existing in the spring, as calculated from the conventional spring formulas, were of a low order.

These failures, so difficult to classify as to cause, present several peculiar features. Life of the springs has been found in general to be somewhat proportional inversely to the camshaft speed. This proposition should be accepted with reservations, however, for reasons which will be explained later. Another fact, which no doubt has been noted commonly, is that, from a given number of springs made from the same material under conditions seemingly identical, some fail after a very short life, whereas others give good service for a long period.

This phenomenal type of failure after comparatively short service nearly always occurs as a fracture in the region of 1 to 1½ coils from the end of the spring. Macroscopic examinations of these fractures disclose them to be fatigue failures. The fracture usually makes an angle of 30 deg. with the axis of the wire and, as a rule, numerous secondary or "incipient" fatigue cracks, making the same angle with the axis, appear in the vicinity of the fracture. It may be contended that these fatigue failures are due to the fact that stress of a higher order than that calculated through the use of static formulas existed in the neighborhood of the fractures. If such a contention is permitted, this stress concentration is definitely linked with the rate of forced vibration of the spring, the natural frequency of the spring, and such factors as the action of inertia forces due to cam acceleration and the weight of reciprocating valve-gear parts. In the following notes the parts that these variables may play in causing this stress concentration are discussed in some detail.

What Occurs in Valve-Gear Operation

It is fitting to discuss briefly at the outset the action that occurs in the valve-gear as it performs its cycle of operation. Starting with the valve closed and the follower resting on the base circle of the cam, the follower travels up the face of the cam as the cam revolves. The relative sharpness of this part of the lift produces an acceleration force many times greater than the resisting force of the spring. Hence, in the initial part of the lift the spring performs little or no work in opening the valve; the control is vested almost wholly in the contour of the cam flank. In this case the acceleration is positive; that is, the velocity of the opening of the valve increases continuously.

At the position of about half-lift, the cam contour changes from the relatively high slope of the flank to the gentler one of the cam nose. The velocity of the opening therefore ceases to increase and the acceleration becomes negative. The spring then comes into action and further opening of the valve is controlled by it. It is obvious that the maximum force acting on the spring occurs at the position of full valve-opening. In the closing of the valve, the reverse of the foregoing action occurs; the control changes from the spring to the cam, and the acceleration of closing changes from negative to positive at the position of approximate half-lift.

To provide a convenient way to study valve-spring surge on various types of valve-gear, a machine capable of reproducing the valve-gear motion described was built. This consists of a shaft and flywheel driven by an induction motor through a variable-speed transmission. The outboard bearing of the shaft is mounted in a cast-iron head upon which is mounted a block containing the valve-gear parts assembled in their correct relation to one another. The cam used to actuate the gear is mounted on the extreme end of the shaft. Speed variation is obtained by means of a handwheel placed at the front

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of the machine and connected to the transmission at the rear. A speed indicator, graduated from 500 to 2500 r.p.m., is geared to the camshaft. Such an assembly comprises a unit that can be adapted to almost any type of poppet-valve mechanism.

If very detailed observations on this set-up are desired some stroboscopic method is required to slow down the motion of the valve assembly so that its peculiarities can be visualized easily. This is particularly true in the case of spring surge, in which the frequencies are very rapid. All the requirements imposed for this work are fulfiled by the vibroscope, which consists of an induction coil that energizes a neon-filled lamp, and a tachometer switch in which a cam makes and breaks the induction-coil circuit at a rate in synchronism with the camshaft speed, or nearly in synchronism, depending upon the slip at the tachometer point. Two No. 6 dry cells are used to energize the coil.

Resonance of Vibrations Causes Spring Surge

Studies made on the valve-gear testing-machine with the aid of the vibroscope and a super-speed motion-picture film enable us to contend that valve-spring surge is largely a matter of resonance between the natural frequency of the spring and the frequency of the forced vibration as related to the camshaft. When a force acts on the spring as a result of the action of the valve mechanism, it tends to set up in the spring a wave motion, the wave-length of which is dependent upon the natural frequency of the spring. If, as is the case in a valve-gear, the force acting is a recurrent one but of low frequency, the spring acts as a part of the system. When the frequency of the forced vibration is low, the force tending to vibrate the spring is small due to the comparatively small centrifugal effect of the cam, and the time between applications of the force is long enough to permit the free vibrations set up in the spring to die out between successive applications. If, however, the forced vibration is of a somewhat high frequency and is of such a value that its wave-length will equal an integral number of the free wave-lengths, a condition of resonance may be created. In this case, the recurrent force is greater, due to the increased centrifugal effect, and the time between successive applications of the force becomes less. If, then, the wave-length of the forced vibration is comparatively long and is of such magnitude that an integral number of the free wave-lengths will be completed during the former wave-length, the applications of force will be in phase and the resulting wave-motion in the spring will be cumulative and resonant.

Following this line of argument, if a spring the natural frequency of which is 10,750 free vibrations per minute is vibrated at a forced rate of 1075 vibrations per minute in the conventional valve set-up, we shall find that the spring surges and emits a tone. The length of the natural-frequency wave will be 0.00558 sec. and that of the forced vibration will be 0.05580 sec. Accordingly, 10 complete waves will be set up in the spring between applications of the force and we shall therefore have a resonant condition. At lower rates of forced vibration there may be no sign of surge. This may be due to either (a) the spring acting as a part of the whole system because the time between applications of the force is long and the magnitude of the force is small, or (b) the amount of the surge being so slight as to escape detection. However, at any time that the forced vibration has a wave-length which will contain an integral number of free wave-lengths, a tendency to create surge will exist.

Calculation of Natural Frequency

A convenient formula for calculating the natural frequency of a spring has been offered by Ricardo, who equates:

$$n = 531 \sqrt{(R/W)} \qquad (1)$$

where

n = complete number of free vibrations per minute of the spring as vibrating in itself
R = rate of the spring, in pounds per inch
W = weight of the active mass in the spring, in pounds

The derivation of Ricardo's formula is simple and can be obtained from a consideration of a spring vibrating with its ends fixed. In this case, each half of the spring may be regarded as working independently of the other half. Then, as one half works as an extension spring, the other half works as a compression spring, and vice versa.

If the central coil of the spring is assumed to move through a distance of a inches, the maximum displacement will be a distance $a/2$ to either side of the rest position. Each half of the spring may then be regarded as an extension spring or a compression spring, moving a distance of $a/2$. Since the amplitude is half the displacement, the amplitude for the half-spring will be $a/4$. The inertia force will then be:

$$F_i = (W/2g)\ (a/48)\ \omega^2 \qquad (2)$$

where

$a/4$ = amplitude, in inches
F_i = inertia force
g = force of gravity
ω = angular velocity of periodic force, or radians divided by seconds
$W/2$ = weight of half the spring, in pounds

Since the rate of the spring in number of pounds required to compress it 1 in. varies inversely with the number of coils, the rate of the half-spring will be $2R$ and the resisting force due to the stiffness of the spring will be:

$$F_r = 2R\ (a/2) = Ra \qquad (3)$$

where

$a/2$ = deflection of the half-spring, in inches
F_r = resisting force
R = rate of the spring, in pounds per inch

These two forces will be equal and opposing, and, hence, by equating the two and evaluating the constants, the formula (1) is obtained.

The natural-frequency formula must be employed with caution, as, notwithstanding design figures, two springs seldom have the same natural period, because of the slight variation in the gage of commercial wire, the slight difference in pitch-diameter, and differences between one spring and another in the number of active coils, all of which affect the rate in pounds and the weight of the active mass of the spring. However, if the design is good, springs designed for the same frequency will all come in, or surge, within a few vibrations per minute of each other. Hence, the formula is valuable for comparative purposes.

Design as Related to Natural Frequency

From the foregoing hypothesis of the nature of valve-spring surge, the obvious inference is that it is good practice to so design valve-springs as to obtain the highest possible natural frequency. This has been found to be true, within limits. Other factors, such as load and stress, being equal, a high-frequency spring is desirable since its wave-length is so high, compared with the wave-length of the disturbing force, that the spring will not vibrate in itself at the lower camshaft-speeds.

Another, and true, inference that can be drawn from the hypothesis is that surge, because of its nature, cannot be eliminated except by recourse to some sort of friction damper which might prove expensive and annoying. It must be expected that, in the present state of the spring art, a spring always will vibrate when the frequency of the disturbing force is an integral part of the frequency of the spring, provided the frequency of the disturbing force is high enough to cause the spring to vibrate of itself. This proviso suggests a possible solution of the problem. Why not so design valve-springs that their frequencies will be so high that they will not tend to vibrate until they have reached forced vibration or camshaft speeds in excess of those encountered in customary practice?

This idea of improving valve-spring surge conditions by increasing the natural frequency of the spring can best be illustrated by the study of an actual problem.

Data relative to the characteristics of two actual springs are given in Table 1. The spring whose characteristics are given in the column headed "Original" was found to have noisy vibrational periods when running in the engine, and, moreover, some cases of breakage in service were reported notwithstanding the low static-value of stress as shown in the table. It was proposed to supplant this spring by one whose characteristics are given in the last column of the table, and in which an endeavor was made to hold to the same approximate valve-loads but to increase the natural frequency of the spring.

TABLE 1—CHARACTERISTICS OF AN ORIGINAL SPRING THAT VIBRATED NOISILY AND A REDESIGNED SPRING IN WHICH THE TROUBLE WAS ELIMINATED

Item	Original Spring	Redesigned Spring
Mean or Pitch Diameter, in.	1.102	0.878
Free Length, in.	3 1/32	2 23/32
Total Number of Coils	10 1/2	9
Gage of Wire, Washburn & Moen No.	9	10 1/2
Load with Valve Open at 2 1/32 In., lb.	48	53
Load with Valve Closed at 2 11/32 In., lb.	29	29
Stress with Valve Open lb. per sq. in.	41,200	57,000
Stress with Valve Closed, lb. per sq. in.	25,300	31,200
Stress Range, lb. per sq. in.	15,900	25,800
Rate, lb. per in.	59.0	77.3
Weight of Active Mass, lb.	0.1435	0.0700
Frequency or Free Vibrations per Minute	10,750	17,600

It may be of interest to mention briefly the way in which this higher frequency of the spring is obtained by design. First, in this case, the pitch-diameter of the spring is decreased considerably, which tends to increase the rate of the spring. But to obtain the correct valve-loading and, at the same time, a reasonable free length, it is important that the rate be not increased excessively, hence the diameter of the wire is reduced somewhat, but the net result is a considerable increase in the rate. It should be noted that the number of active coils also affects the rate and that this number is varied to vary the rate. The weight of the active mass in the spring is decreased by reducing the diameter of the wire, the pitch-diameter, and the number of active coils. The increase of rate together with the decrease of mass effects a substantial increase in the natural frequency of the spring in accordance with Ricardo's formula.

The two springs mentioned were studied by means of the equipment designed for this purpose and previously described. Their surge characteristics were noted and a marked difference in favor of the redesigned spring was found. Surge periods in the original spring were noted at camshaft speeds as low as 560 r.p.m. From this speed upward periods were noted at intervals that coincided somewhat closely with the intervals obtained by dividing the spring frequency by whole numbers. It was found, however, not only with this spring but also in other cases, that at some times a period of a certain camshaft-speed gave less surge and noise than the one at the next higher speed at which surge was noted. This is difficult to explain and does not harmonize well with the hypothesis presented as to the cause of surge. Perhaps the reason for this seeming discrepancy lies in the fact that the period of greater surge occurs at a speed which may be critical for one or more parts of the valve-gear, and that it is the resonant vibration of these parts, in addition to the spring, that causes the increased noise. So far as the spring is concerned, the discrepancy does not invalidate the surge hypothesis, for, as pointed out, the observed periods corresponded closely, in a general way, with the calculated spring-frequency. The redesigned spring had no periods of appreciable magnitude until a camshaft speed of 1330 r.p.m. was reached, and at even this period the magnitude was so small that it was difficult to observe.

How Surge Affects Spring Stresses

Surge, if excessive, may cause the valve to float open and thus impede the operation of the engine or it may cause excessive hum and make an engine more noisy than it should be. In any case, it always causes, to a greater or less degree, a building up of stress which is deleterious to the fatigue-life of the spring. Upon this last premise we account for the phenomenal failures of valve-springs, as mentioned in the initial part of these notes.

The pictures of valve-springs in operation, reproduced in Fig. 1, are cut and enlarged from individual frames of a super-speed motion picture taken of the original and redesigned springs discussed herein. A study of them will reveal the way in which the wave motion, set up by the spring vibrating in itself, affects the stresses existing in the spring. It can be seen that, as the spring is vibrating in its own period, certain coils may, at a given instant, be compressed solid, while others may be opened up beyond their normal position for an equivalent static compression by an amount which may be as great as or greater than a half pitch of the particular coil. At an instant one free wave later, the conditions are exactly reversed. Thus, while the stress range statically may amount to 15,900 lb. per sq. in., the stress range in vibratory operation may vary between zero and solid stress, or even greater than the latter, depending upon the amount of impact due to coil clash.

To be a little more specific about this stress range, the stresses on the spring whose natural period was 10,750 free vibrations per minute ran as follows:

	Stress, Lb. per Sq. In.
Spring compressed solid	69,000
With valve open	42,200
With valve closed	25,300

When this spring is vibrating severely in its own period, the coils which are closed and clashing will be stressed 69,000 lb. per sq. in., or even more, depending upon the impact value of the coil clash. At the same instant, a coil at the opposite end of the spring will be opened up a certain amount, due to the wave motion. If the latter coil is opened up an amount which will make its pitch at that instant equal to its pitch when the spring

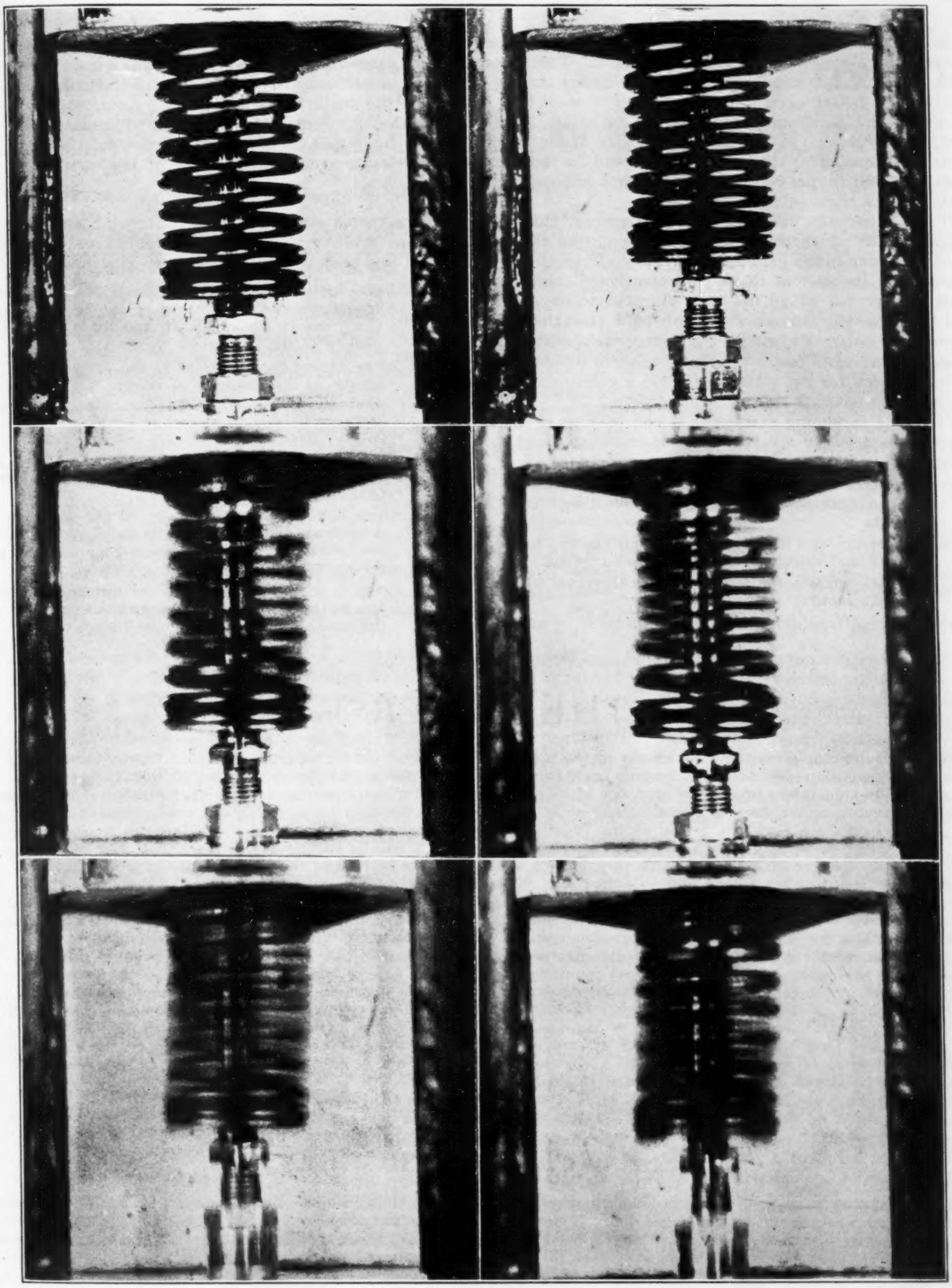

FIG. 1—WAVE MOTION IN A VALVE-SPRING AS REVEALED BY ENLARGED INDIVIDUAL EXPOSURES FROM A MOTION-PICTURE FILM
The Upper Left Picture, Taken with the Poppet Valve Closed, and the Upper Right Picture, Taken with the Valve Open, with the Camshaft Rotating at Very Slow Speed in Both Instances, Show No Vibration of the Spring Coils. The Four Other Photographs Show the Coils Surging When the Spring Is Vibrated 1490 Times per Minute. When Vibrating in Its Own Period, Certain Coils May, at a Given Instant, Be Compressed upon Each Other While Other Coils May Be Spread Apart beyond Their Normal Position for an Equivalent Static Compression by a Half Pitch of the Coil or More. Both Middle Views Were Taken with the Valve Closed, the One at the Right an Instant Later Than the One at the Left. The Lower Two Views Were Taken with the Valve Open and the Coils Surging, the Exposure at the Right Having Been Made an Instant Later than That at the Left. Whereas the Stress Range Statically May Amount to 15,900 Lb. per Sq. In., the Stress Range in Vibratory Operation May Vary Between Zero and Solid Stress or More

is in a free or totally unloaded condition, then the stress range will be 69,000 lb. per sq. in. or more. This, however, is a very extreme case, and it can be seen that this condition is not reached in any of the pictures in Fig. 1, in which the maximum pitch-opening is about 50 per cent greater than the normal pitch under static conditions. Accordingly, the stress range will be approximately 56,300 lb. per sq. in., but it is not impossible to realize cases more extreme than this.

It is especially important to remember that the rapidity with which this stress range is passed through is of an order much greater than camshaft speed. For example, in the case of the spring mentioned, which has a natural period of 10,750 free vibrations per minute and is being vibrated at a rate of 1075 vibrations per minute, the entire abnormally high stress-range will pass from the maximum to the minimum value in 0.00558 sec., or in the time for the wave to assume a position exactly out of phase with its former position.

From the foregoing discussion it can be seen that the effect of surge upon a valve-spring is to bring about the following conditions:

(1) Existence of a maximum stress of a higher value than that calculated by the conventional formula

(2) Occurrence of a higher stress-range in the end coils than that calculated on a static basis

(3) A state whereby the stress-range is traversed with great rapidity

All investigations along the line of metal fatigue tend to show that fatigue life is a function of the maximum stress existing, the stress range through which the material is worked, and the total number of oscillations to which the material is subjected. Accordingly, the abnormal stress conditions and the abnormal rapidity with which the stress range is crossed, due to the surge, tend to accelerate greatly the fatigue of the spring.

Four Major Contentions Advanced

These notes suffice for us to advance four major contentions relative to the general subject of valve-spring surge, and they can be summarized as follows:

(1) Valve-spring surge is a product of a resonant condition between the rate of the forced vibrations, due to the camshaft, and the natural frequency of the spring

(2) Surge cannot be eliminated in the present type of spring, as the tendency to vibrate is an inherent characteristic of a spring. A solution is offered, however, by designing springs for high frequency so that they will not vibrate until they are subjected to rates of forced vibration in excess of speeds above the range of normal maximum camshaft speeds

(3) Surge is affected by the design of the valve-gear. A tendency to magnify spring surge may exist if one or more parts of the valve-gear are also in resonance with the spring

(4) Surge is a prolific source of valve-spring failure, due to the stress conditions and the rapidity of the stress cycle set up by the surge

THE UNIVERSE

FROM believing ourselves to be the center of the universe and its raison d'être, we now know that our earth is merely a damp, moldy atom, hung to a minor star, one of billions of other suns that together form a spiral-looking object very like a Fourth of July pinwheel. One of the functions of this spiral seems to be to generate suns as it revolves, but it also has the disconcerting job of flying through space at the incredible speed of more than 700 miles per sec. The starry heavens that we have called our universe becomes, then, a hurricane of gas, dust, lumps, and fireballs, hurtling through space at a speed hundreds of times greater than that of a bullet and in such a state of turmoil and confusion that collisions and explosions are the common and regular order of events. But our degradation from the important central position, which we pictured as ours, does not stop with this discovery; it goes on to untold lengths, for it has also been shown that our spiral universe is only one of millions of other such universes, all very like ours, and all flying through space at terrific speeds and without any discernible order. The great 100-in. telescope at Mount Wilson, penetrating into space for a distance of about 140,000,000 light-years, discloses spiral universes out to its very limit of penetration. If the 300-in. mirror, which is already planned, is ever constructed, there is no doubt at all that the number of known spirals will be enormously increased. It has been estimated that the horizon of the new instrument will be 6,000 million, million, million miles away.

With the accumulating energy acquired from uniting hydrogen atoms, it is believed that our sun will again become a nova, that is, will again expand to the orbit of the outermost planet. New stars appear with great regularity in our nebula, and, judging the age of the earth from radioactive minerals, and taking into account the approximate number of stars in our galaxy, it has been estimated that it will be the sun's turn to explode again in about 50,000,000 years. If such a thing occurs, all trace of life on the earth will be snuffed out in an instant.—J. F. Porter in *Harvard Alumni Bulletin.*

RESEARCH AND PROGRESS

DO not feel that your task is finished, but that you are living and working on an unfinished job. If you can become sufficiently dissatisfied with something in your business to make it keep you awake, you will start to make progress. As long as a man can sleep and work on his job, he will not accomplish very much. It has got to worry you enough to keep you awake before you make progress. Only in the economic stress of having to do a thing do our lazy minds become lashed into enough energy to go to work.

Suppose you and I were fired out of our particular jobs today and wanted to go into competition with the company we are in today. What would we do differently from what we are doing now? You would do something differently, because you know the weak points of your own organization. Why not do that without going across the street? Make yourself your own competitor. Say,

> Today we are fired, and tomorrow we will start a new business. What are the things that we are going to avoid that this company has not avoided?

Start to do that today and you do not need to be fired.

Progress is as limitless as space. We have only started. A smile and a dissatisfaction with what you have is the progress of tomorrow.—C. F. Kettering before American Foundrymen's Association.

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Head-Lamp Focusing Mechanisms and How They Affect Law Enforcement

By Alfred W. Devine[1]

Semi-Annual Meeting Paper *Illustrated with* Drawings

ABSTRACT

IT is common practice to provide single-filament motor-vehicle head-lamps with but one focus-adjusting mechanism. The advisability of incorporating also a vertical-focusing mechanism in two-filament tilting-beam head-lamps has been a subject of discussion.

The intent of State laws is to require the proper use of lighting equipment that meets the legal requirements. Focusing is the most difficult obstacle in the way of practical enforcement of the laws. Types of focusing mechanism are described and the effect of the use of each type on the instructions issued by State motor-vehicle departments is explained at some length.

Movement of the light source by the use of the different types of mechanism for focusing head-lamps is described to explain complications that attend the use of multiple adjusting-mechanisms. Head-lamps can be designed with a focal zone, instead of a focal point, so that they will be less sensitive to filament positioning. A sampling of bulbs in dealers' stocks shows that the variation in accuracy of commercial electric incandescent lamps is within the practical limits of compensated single-focus design.

Comparison is made between the adjustment of head-lamps in service which have one focusing-mechanism and two focusing-mechanisms. The deterrent effect of multiple-adjustment mechanisms on future development is discussed.

Proposals to rectify unsatisfactory night-driving conditions should be based upon the elimination of their primary causes. Various authorities agree with these views. The different uses of the vertical adjustment are considered.

IT has been common practice in the design and construction of single-filament motor-vehicle head-lamps to provide one focusing mechanism for the movement of the electric incandescent lamp in a horizontal direction along the axis of the reflector. No provision for horizontal movement of the electric lamp at right angles to the reflector axis is necessary, because a sidewise movement of the filament has practically no effect on the relatively important vertical distribution of light in the beam and because the effect on the horizontal distribution is negligible. The other possible adjustments for exactly locating the filament in its designed position, namely (*a*) vertical movement of the filament without rotation, (*b*) rotation of the filament in a vertical plane through the reflector axis, (*c*) rotation of the filament in a vertical plane normal to the reflector axis, and (*d*) rotation of the filament in a horizontal plane, offer such practical complications that the installation of focusing mechanisms to accomplish these adjustments has almost never been considered seriously. The most necessary of these four, which is (*a*), has been approximated in practice ordinarily by a simple reversal of the electric lamp in its socket, thereby enabling the operator to select the better of two beam patterns and affording the opportunity of compensating for any slight misplacement of the socket in the reflector by an opposite misplacement of the filament of the incandescent lamp.

Three years ago the first head-lamp equipped with an electric incandescent lamp of the two-filament tilting-beam type was submitted to the motor-vehicle administrators of the various States to be considered for approval. With its advent, the question of the advisability of incorporating an additional vertical-focusing mechanism in such head-lamps was brought prominently to the fore. Some head-lamps of this tilting-beam type have been approved in the various States with the one conventional horizontal-focusing mechanism and others have been approved with the added vertical adjustment. The Massachusetts Registry of Motor Vehicles has not favored the use of more than one focusing mechanism since that construction was first proposed. However, it is not unusual for a motor-vehicle administrator to approve of a head-lamp incorporating some questionable features when data are not at hand to justify reaching a final decision against the use of the device. Such a course must be taken at times so that a development which might result in improvement shall not be prevented.

A doubt has existed in the minds of some regarding the relative merits of head-lamps equipped with single focusing-mechanisms and those with double adjustments. In this paper are presented some of the facts that the Massachusetts Registry of Motor Vehicles has learned about this problem. The paper is confined chiefly to discussion of head-lamps of the tilting-beam type in which the two-filament lamp is used. The present form of this electric lamp, as shown in Fig. 1, has two 21-cp. filaments, each similar in shape and size to that in the single-filament lamp. They are placed 9/64 in. apart, parallel to each other, and are equally spaced one above and the other below the axis of the electric lamp as it sets in the head-lamp. As the operator lights one filament or the other by means of a switch near the steering-wheel, the effect is to elevate or depress the beam.

Requirements for Compliance with Law

Two general requirements that must be fulfiled if the results intended by the different State laws are to be obtained are: (*a*) the motor-vehicle must have acceptable headlighting equipment and (*b*) that equipment must be used properly. Compliance with the first requirement is easy to enforce. No question arises whether or not a vehicle is equipped with head-lamps or devices which have been found acceptable and approved for use, as these are marked plainly with distinctive names for identification. The owner of the car cannot fail to un-

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derstand, when so informed, that he must use equipment which has been approved and no other.

Compliance with the second requirement is an entirely different matter. The proper use of headlighting equipment necessitates its careful adjustment and proper operation after it has been adjusted. The typical set of brief instructions for the adjustment of head-lamps is issued by the State in a series of seven, as follows:

(1) Place the car on a level surface so that the head-lamps are 25 ft. from a wall or screen
(2) Examine bulbs and reflectors. Repair or replace if necessary
(3) See that the lenses are installed right side up so that they cannot turn in the lamp door
(4) Examine focusing mechanism. See that it works freely but will not jar out of adjustment
(5) Light the lamps. Cover one at a time and focus the other. Always focus with the lenses in place if the lamps have an outside adjustment
(6) Measure the distance from the floor to the center of the head-lamps and subtract the loading allowance shown on the table for your type of car. Then make a mark on the wall or screen at that height. (A table of loading allowances accompanies the State instructions.)
(7) Tip or bend each head-lamp so that the top of the beam on the wall comes even with the mark

Instructions (1) and (2) are easy to understand. Burned-out or otherwise defective bulbs must be replaced and damaged reflectors must be repaired or replaced. With regard to (3), if the lens is loose it must be fastened so that it cannot rotate. The more difficult part is reached at (4), which necessitates a knowledge of what the focusing mechanism is and how it works. Requirement (5) further confuses the motorist, as it necessitates study and understanding of the instruction on how to focus head-lamps before the operation is performed. Instruction (6) is clear and means simply that a mark be made on the wall at such a height that, when the top of the beam is brought to this mark, the beam will not rise above the lamp centers when the car is on a level road, even when it is loaded with passengers. Requirement (7) is understood without difficulty.

It will be noted that the car is first placed in position and the head-lamps examined for defects. Second, the head-lamps are focused; and, third, they are set to point in the proper direction. Only one of these three groups of operations suggests a real complication in the enforcement problem. It relates to focusing. Requirements (4) and (5) offer more difficulty to the realization of the intent of our laws than all other requirements of equipment and adjustment combined. This is because they necessitate an understanding of something which is not common knowledge and which can be understood only after applied study of the subject.

An understanding of the focusing of a head-lamp is necessary before the problems of the motor-vehicle administrator in disseminating this knowledge and enforcing the law can be appreciated.

Focusing and Focusing Mechanisms Explained

The operation of focusing may be explained as the movement of the electric lamp within the reflector until the glowing filament which constitutes the light source is in a certain definite position for which the head-lamp has been designed. The movement of the lamp and its light source within the usual paraboloidal reflector is accompanied by a marked change in the beam projected by the head-lamp as to (*a*) intensity, (*b*) area illuminated, and (*c*) height of the top of the beam above the ground. The focusing mechanism is provided for the purpose of moving the electric lamp until it is in such a position that the proper beam is obtained. Cross-sections of three head-lamps are shown in Fig. 2. The head-lamp on the left is of the so-called fixed-focus type. The socket for the electric lamp is fastened permanently to the reflector and no provision is made for movement of the bulb. If the head-lamp is properly designed and constructed, a desirable beam pattern will be obtained by the mere insertion of the electric lamp, and no focusing is necessary.

The head-lamp in the center of Fig. 2 has one focus-adjusting mechanism that moves the electric lamp horizontally along the center line of the reflector. This design is typical of head-lamps with a single-filament lamp which are and have been commonly used. The focusing mechanism for this adjustment includes a screw, the head of which projects through the back of the head-lamp shell. As the screw is turned the electric lamp moves either forward or backward in relation to the reflector.

The head-lamp shown on the right has an adjusting mechanism like that in the middle head-lamp and also has a mechanism which moves the electric lamp up and down. This second focusing mechanism includes a second screw, which usually is located below the first and also has its head projecting through the back of the head-lamp shell. As this screw is turned it rotates the small eccentric shown in detail below at the right and moves the electric lamp up or down in the reflector.

Consider how the instructions issued by the various States for head-lamp adjustment are affected by the use of each of these types of head-lamp. Instructions for those of the fixed-focus type are to examine the head-lamps for defects and aim them so that the beam is entirely below the head-lamp level. If all head-lamps were constructed to give satisfactory results with no focusing adjustment, the complicated part of the instructions relating to focusing could be omitted. Use of head-lamps of the two-filament type with one focusing adjustment requires that the instructions issued by the State Motor-Vehicle Administrator explain focusing somewhat as follows:

> Provision is made in the head-lamp for moving the bulb forward and backward in the reflector. This is called the focusing adjustment, and focusing is accomplished by turning a screw that projects through the back of the lamp. With the lenses installed and one lamp covered, turn the focusing screw in one direction or the other until the beam on the wall is as narrow as possible and has a clearly defined upper outline. Turning the bulb over in the socket may improve results.

The use of head-lamps of the two-filament tilting-beam type equipped with two focusing-screws necessitates a different explanation of focusing. Attempts to write such an explanation did not indicate any way of wording it in such practical form that the novice might follow it and make the adjustment *from any and every position in which it is possible for the light source to be at the time the adjustment is attempted.* The reason for this will become apparent. It has been hoped that the motorist might be as easily instructed to keep his head-lamps in proper condition as to care for his tires, spark-plugs, and other parts of his car, but if head-lamps with two or more focusing adjustments are to be used commonly, the attending instruction complications will render such a program hopeless.

Why difficulty is experienced in describing and making

focusing adjustments with the double mechanism will be explained by reference to Fig. 3. As stated, the operation of focusing is the movement of the electric lamp until the glowing filament is at a certain position within the reflector. There is only one such correct position for the light source in each customary reflector, and this is shown by the solid black spot in each of the three views of the cross-section of a reflector.

The drawing on the left shows but one location for the light source. The spot in the axis represents the position of the filament in a fixed-focus single-filament head-lamp. The middle drawing shows several circles 1/16 in. apart along the horizontal center-line of the reflector. These represent the various positions to which the single light-source may be moved by a single focusing-screw of the conventional type. The black spot represents the correct position of the light source. The head-lamp is focused by moving the electric lamp until the light source reaches this position, as judged by the appearance of the beam on a wall or screen. The movement of the filament is along one line only, and therefore, when the focusing screw is turned from one limit of motion to the other limit, the adjuster must necessarily move the light source through that point producing the most desirable beam. As the filament is moved forward or backward from this position, the beam enlarges and the top cut-off of the beam becomes vague; thus the adjuster knows definitely when he has the correct adjustment.

The drawing on the right shows several rows of circles, one on the center line of the reflector and others above and below it. These circles represent the positions of the two light-sources which may be obtained in a tilting-beam head-lamp by the operation of two focusing screws, one of which moves the electric lamp forward and backward, as described for the middle view, and the other moves it up and down. It is important to note that the operation of the focusing screws does not necessarily move the electric lamp through that position in which the light sources are correctly placed. From this fact arises the difficulty of explaining the method of making the focusing adjustment.

Some inaccuracies in electric lamp or head-lamp construction may similarly or variously affect the results obtainable with head-lamps of any of the three types shown. The fixed-focus head-lamp may give results that are satisfactory in a greater or less degree owing to deviation of the positioning of the filament in any direc-

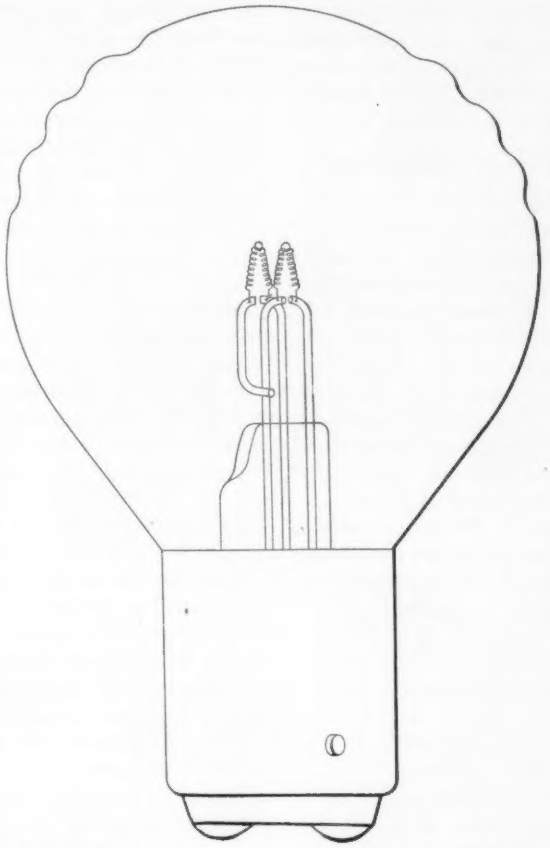

Fig. 1—Two-Filament Tilting-Beam Electric Lamp
Each of the Filaments Is of 21 Cp. and They Are Placed Parallel to Each Other 9/64 In. Apart. They Are Equally Spaced, One Above and the Other Below the Axis of the Electric Lamp. As the Car Driver Switches the Current from One Filament to the Other, the Effect Is To Elevate or Depress the Beam of the Head-Lamp

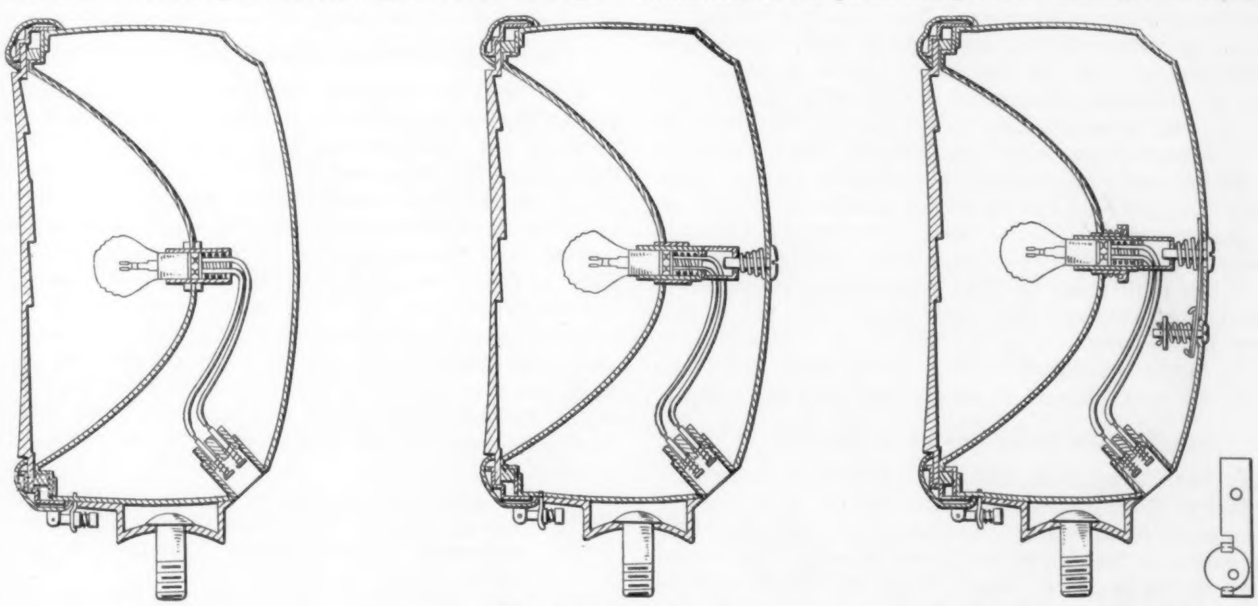

Fig. 2—Head-Lamps with Fixed Focus and with Single and Double Focusing-Adjustments
The Fixed-Focus Head-Lamp, at the Left, Has a Permanent Socket at the Center of the Reflector and No Provision for Movement of the Electric Lamp. If This Head-Lamp Is Built Accurately, the Mere Insertion of the Electric Lamp Is All That Is Necessary To Focus the Light Properly. The Head-Lamp in the Middle Has One Focus-Adjusting Mechanism Operated by a Screw That Protrudes through the Rear of the Head-Lamp Shell and Moves the Electric Lamp Horizontally along the Axis of the Reflector, Either Forward or Backward. This Adjustment Is Typical of Head-Lamps Using the Single-Filament Electric Lamp. The Head-Lamp at the Right Has, in Addition To and Below the Horizontal-Focusing Mechanism, a Supplemental Vertical-Focusing Mechanism Which Tilts the Electric Lamp Up or Down. This Movement Is Accomplished by Turning a Screw Which Rotates the Small Eccentric Shown in the Lower Right Corner of the Figure

tion, and the two other types of head-lamp may be sensitive to variations except those which may be corrected for by the respective adjustments. Six focus-adjusting mechanisms would be necessary to correct for all possible inaccuracies in filament positioning.

Practical Operation Limited to One Adjustment

The question then arises, How many of these mechanisms, if installed in head-lamps, might reasonably be expected to improve conditions in practice? The fact cannot be evaded that the finer adjustment made possible with multiple focusing-mechanisms is accompanied by rapidly increasing and unmanageable complications as the number of adjustments is increased. One focusing adjustment is the limit for practical operation by the motorist or even by approved adjusters. Strong probability exists that, when two focusing mechanisms are provided, the adjuster will move the electric lamp all around its correct position without locating that position. The novice cannot tell when he is near it. First he turns one screw, then the other, without knowing how the bulb is moving, for he cannot see it. It is not pictured before him as in Fig. 3. The filament moves in a zig-zag course throughout the region shown by the circles and, as likely as not, finally comes to rest in a far corner of the area, with resulting disgust of the adjuster and dissatisfaction of the car operator.

Cooperation of the motorist is necessary before we can hope to improve conditions materially. The motorist should not have to be driven to better lighting. Defects in the design and construction of head-lamps, which have made it hard to secure the best road-light from them initially and have given no assurance that they would stay in adjustment, have been responsible largely for the attitude of the motoring public. The official approval of complete head-lamps promises to eliminate this difficulty eventually. Adjustment complications are an added stumbling block. Possibly it is hoping too much to expect that motorists will be educated some day to adjust their own head-lamps. Certainly this is the case with the double-focusing mechanism. The inherent difficulties in obtaining proper initial adjustment and maintaining such adjustment over an acceptable period must be recognized as attending the use of double-adjustment head-lamps, and the same reaction on the part of the motorist may be expected as with single-beam head-lamps of faulty design and construction that are now on the roads.

It has been pointed out clearly a number of times recently that the manufacturer has not in the past assumed the responsibility which was rightfully his. A requirement of the additional vertical adjustment would shift the burden of responsibility partially from the manufacturer to the user. This movement of responsibility should be in the reverse direction. Head-lamps should be placed in the users' hands as nearly foolproof as possible.

Insensitive Head-Lamps a Reality

It has been explained that the customary reflectors shown in Fig. 3 may be sensitive to various inaccuracies, but it is possible to design head-lamps so that they will be insensitive to the inaccuracies which might otherwise cause trouble in practice. Such designing results practically in the development of a focal zone that would be represented in Fig. 3 by solid black spots several times as large as those shown. Head-lamps so designed will perform in a satisfactory way if the filament is anywhere within that area. This design eliminates the necessity for bringing the light source to the exact focus. Head-lamps of this type have been approved for use in the various States, and it can be demonstrated that they will perform in a satisfactory way with the variations in filament locating which may be expected in practice. I have made such demonstrations with electric lamps which have filaments misplaced vertically 0.055 in., a degree of inaccuracy that is greater than any found in a recent sampling of dealers' stocks. By turning the bulb over, that displacement may be upward or downward, yet the head-lamp gives a satisfactory beam with the electric lamp either way.

Samples of double-filament electric lamps were gathered recently from 40 dealers in the following Massachusetts cities: Boston, Worcester, Springfield, Lynn, Lawrence, Salem, Gloucester, Quincy, Fall River, and New Bedford. One lamp was taken at random from each box of 10 in each dealer's stock, except that not more than 10 boxes were sampled at any one dealer's place. The total number of electric lamps thus accumulated was 244, of the following brands: National General Electric, Edison Ever-Ready, Westinghouse, Edison General Electric, and Tung Sol. All were measured carefully and the results of tests for vertical misplacement of filaments are shown in Table 1. This is the only electric lamp inaccuracy now in question, because any others affect the results from head-lamps of either the single-focusing or double-focusing type equally. These variations of commercial electric lamps within 0.05 in. are within the practical limits of compensated single-focus design.

TABLE 1—VERTICAL MISPLACEMENT OF FILAMENTS IN SAMPLE ELECTRIC INCANDESCENT LAMPS OF FIVE BRANDS COLLECTED FROM DEALERS' STOCKS

Number of Incandescent Lamps	Vertical Filament Deviation, In.
52	0.00
85	0.01
66	0.02
29	0.03
11	0.04
1	0.05
Total 244	Average Deviation, In. 0.014

Practical Difficulties of Multiple Focusing

It is next in order to consider in greater detail the possibility of securing in practice a finer focal adjustment of the light source with more than one focusing mechanism, as compared with the results obtained when one or no focusing mechanism is provided. If better results are to be obtained these four requirements must be fulfiled: (*a*) the mechanism of the additional adjustment must be free from mechanical difficulties such as sticking and looseness; (*b*) the lamp must be adjusted; (*c*) the adjuster must understand the functions of the various adjusting mechanisms; and (*d*) the adjustment must be made by a person who has had experience in correctly using multiple-adjustment mechanism. The following conditions prevent the fulfilment of these requirements in practice:

(1) The additional mechanism of the multiple focusing-adjustment head-lamp is accompanied by additional manufacturing inaccuracies which cause trouble in service

(2) Many head-lamps in service are not adjusted. Improper adjustment with the vertical-focusing screw will throw the head-lamp farther out of adjustment than is possible when this screw is not provided

(3) Very few motorists understand how to focus their own head-lamps, particularly when the lamps are complicated by more than one adjustment

(4) The second adjustment permits gross misuse of the head-lamp

The Massachusetts Registry of Motor Vehicles has on file an approved head-lamp of the type (1) which has a looseness in the vertical-focusing mechanism that permits 0.09 in. vertical movement of the light source without turning the focusing screw. It is a common complaint, whether justifiable or not, that single-focusing-adjustment head-lamps jar out of adjustment in service. How much more cause for complaint of difficulty on that score there would be if multiple focusing-adjustments were to be commonly used.

I have demonstrated (2) to be a fact. The condition of non-adjusted multiple-focusing head-lamps must therefore be worse in service than non-adjusted single-focusing head-lamps. The extent of compliance with the headlighting law differs in the different States but undoubtedly is larger in Massachusetts than in any other State. An analysis of the condition of the head-lamps on 1156 vehicles that were stopped in succession in the State in 1925 showed 41 per cent improperly focused. If this condition is general it means that if all head-lamps had multiple-focusing mechanisms 41 per cent of them, as a group, would be in worse condition than if all head-lamps had only one adjustment.

To secure some data on (3) two of the State inspectors, in July, 1926, stopped 125 cars equipped with either of the two approved makes of head-lamp which have two focus-adjusting mechanisms. It was found that only one of the 125 operators understood how to adjust these head-lamps. Of these operators 67 were owners, 38 were chauffeurs and the other 20 were owners' relatives, friends, or employes other than chauffeurs. Even those who have had experience in adjusting head-lamps do not understand the proper use of multiple focusing-adjustments, about which, to the non-technical mind, there is something mysterious and baffling.

In Massachusetts there are approximately 1500 approved head-lamp adjusters, some of whom have been doing this work for 5 years and have become skillful in it. Foremost among these are undoubtedly the skilled mechanics at the service stations for the medium and high-priced cars in Boston. One such station has three adjusting stands and for the last 5 years the head-lamps of all cars have been adjusted before they left the service station. An investigation was made to determine how well the adjusters in such stations were able to check one another in making focusing adjustments on head-lamps equipped with two adjusting mechanisms. Two experienced motor-vehicle inspectors visited service stations of certain makes of car on which double-focusing head-lamps are standard equipment. At each station adjustments were made on each of several head-lamps by the inspectors and by the approved head-lamp adjusters at that station. After each adjustment the head-lamp was thrown completely out of adjustment before the succeeding adjuster touched it. The vertical placement of the filaments was measured in each case. Adjustments were made on 22 different head-lamps. In his report on this work the inspector says:

> In each case they focused the head-lamp with the upper screw and aimed the beam with the lower screw, instead of focusing the lamp with both screws and aiming it with the swivel bracket designed for that

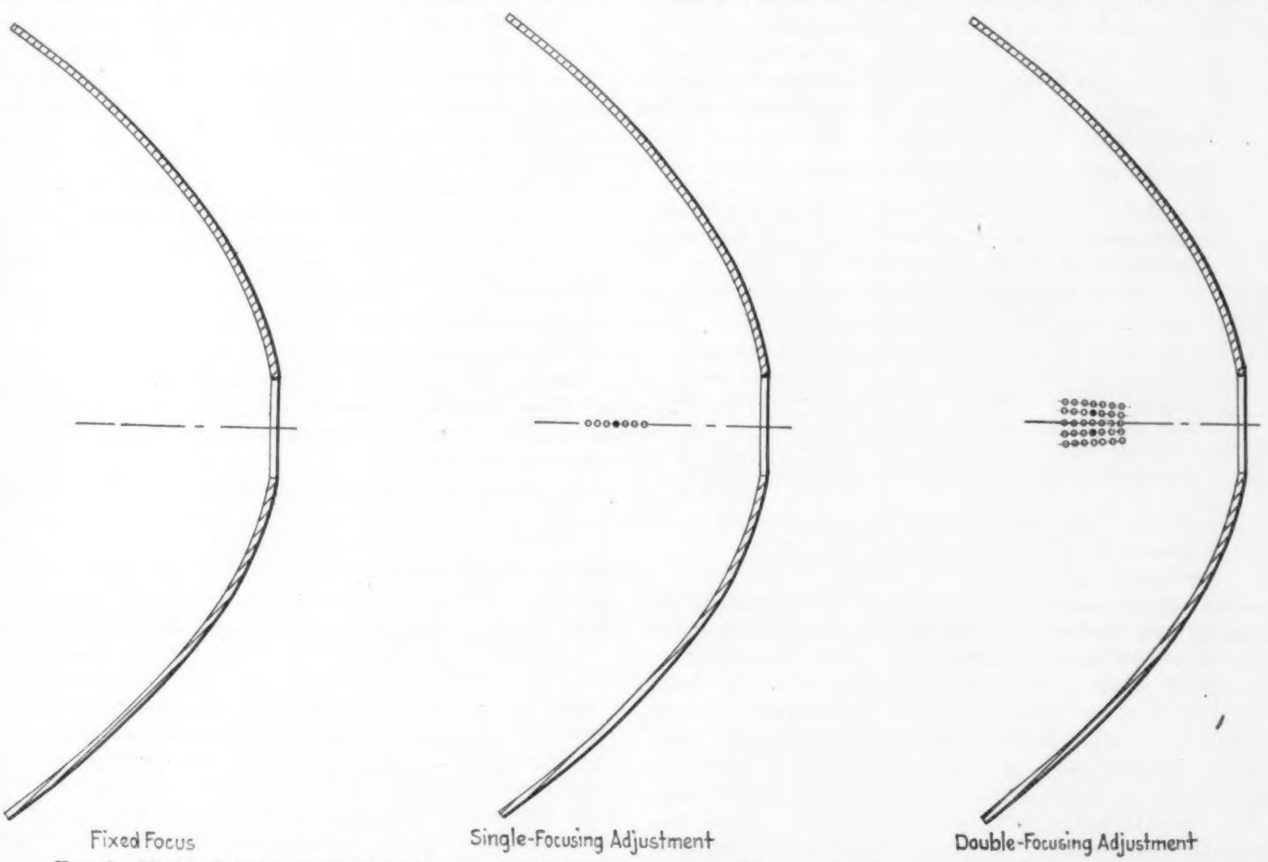

Fig. 3—Focal Points in Reflectors Having Non-Adjustable, Single-Focusing, and Double-Focusing Sockets

The Spot in the Axis of the Reflector at the Left Indicates the Correct Location of the Filament in the Fixed-Focus Head-Lamp. No Other Position Is Possible When the Electric Lamp Is Inserted if Head-Lamp and Electric Lamp Are Made with Accuracy. In the Single-Focusing Type of Head-Lamp in the Middle the Electric Lamp May Be Adjusted to Any Location on the Axis Indicated by the Series of Circles. The Solid Spot Shows the Only Position for Correct Focus. In the Double-Focusing Type, the Filament Can Be Adjusted Both Longitudinally and Either Above or Below the Axis, as Shown at the Right. The Correct Locations of the Filaments Are As Indicated by the Black Spots. Operation of the Focusing Screws Does Not Necessarily Move the Electric Lamp through These Positions.

purpose. No two adjusters, when finished adjusting, left the screws in the same position. The slack in the vertical adjustment permits the beam to be raised or lowered 3 in. on the target without turning the screws.

Variations in the vertical placement of the filaments for each of the 22 different head-lamps measured from 0.020 to 0.110 in. and averaged 0.040 in. This is, at best, the equivalent of plus or minus 0.020 in. On the other hand, electric lamps are manufactured that are within an average of plus or minus 0.014 in., as indicated by the data in Table 1 and substantiated by numerous other data which have been collected. This indicates that, even if skilled adjusters made all the adjustments on every car with double-focusing head-lamps, the variation from designed vertical positioning would be greater by reason of the variation in judgment of the different adjusters than would occur if the adjustment were eliminated and the variations introduced instead. This conclusion is corroborated by those best qualified to give an opinion.

With reference to (4), if the vertical adjustment is used for aiming the head-lamp, it disregards the best adjustment of the electric lamp, for which it is supposed to be designed, and disregards the claimed necessity for correcting for variations in electric lamp accuracy. It permits displacement of the electric lamp to such an extent in some cases that a negative tilt may be obtained. A slight movement of the vertical-adjustment mechanism has a marked effect on the elevation of the beam and therefore permits quick elevation of the beam after the head-lamps have been properly aimed by a qualified person. It increases the possibility of tinkering manipulation and therefore is almost certain to result in worse conditions, because it is an optical adjustment placed in the hands of unskilled manipulators. Real improvement can be obtained only when head-lamps are constructed so that the necessity for any scientific knowledge on the part of the operator is eliminated.

Would Retard Headlighting Development

It is doubtful if anyone feels that present conditions cannot be improved. Future development and improvement in headlighting would be retarded by the requirement of a vertical-focusing adjustment, in addition to the usual mechanism, for the following reasons:

(1) The addition of adjusting mechanism to compensate for variations that occur in manufacture removes the incentive for the elimination of those variations by the producer
(2) The second adjustment does not make possible a correction for all variations in light-source location
(3) Head-lamps can be and are designed and constructed to be relatively insensitive to the vertical positioning of the filament

Amplifying (1), a requirement of an additional focusing adjustment renders unnecessary to some extent the production of accurate electric lamps and the accurate placement of lamp sockets in reflectors. It has been estimated that three times as many inaccurate electric lamps and inaccurate head-lamps can be produced with the same overhead cost as a given number of accurate electric lamps or head-lamps. One cannot doubt that, with the incentive for accurate construction removed, the manufacturer who is working under keen competition will pay little heed to accurate construction. The elimination of focusing adjustments makes more accurate construction necessary, and the manufacturers of electric lamps and head-lamps should be encouraged in this direction. The eventual final improvement which is sought in headlighting would be postponed by the requirement of a supplemental vertical-adjustment and would not be realized until after the incentive for accurate construction was restored by the elimination of such a requirement.

Six focusing adjustments would be necessary to accomplish the correction mentioned in (2). With the incentive for accurate construction removed by the requirement of a supplemental vertical adjustment, it would be only a question of time when it would be necessary to provide still more adjustments to take care of these other variations. It is apparent that a start in this direction might make night-driving conditions progressively worse.

Every encouragement should be given to the manufacturer to develop construction in the direction of (3). This is the type of development which leads to the eventual elimination of all focusing adjustments and is a movement which should be supported strongly. The construction of electric lamps for head-lamp use has been in process of rapid development and improvement during the last several years. It has been accentuated by the action of the Registrar of Motor Vehicles in Massachusetts in issuing tentative specifications for approval of two-filament lamps followed by his approval of electric lamps complying with these specifications. He has also requested the Bureau of Standards to consider the adoption of similar specifications so that the Massachusetts approvals may be given subject to compliance with Government specifications. Uniformity will thereby be promoted.

Remedies Applied to Causes of Difficulties

Much thought has been given, both individually and collectively, to the solution of the headlighting problem. As a result, changes have been proposed that vary from radical alterations in the basic system to different construction of the head-lamp in its minor details. In considering such matters it is only too easy to make the mistake of losing sight of the fundamental causes of trouble and propose some corrective measure such as the second focusing adjustment which does not strike at the root of the difficulty. The primary sources of dissatisfaction with our present system of headlight control are the motorists' lack of understanding or wilful neglect of the care and adjustment of head-lamps, and the inaccurate construction of head-lamp parts. Rectification of these matters necessitates the simplification of all head-lamp adjustment and the better construction of each important part.

It is clearly apparent that the use of a supplemental vertical focusing-adjustment to correct for inaccuracies in filament placement is contrary to the first principle which should underlie every effort at improvement. It aims to correct a difficulty indirectly by compensation. How much better it is not to add any complication to adjustment but, instead, to eliminate the cause of difficulty by better construction or better design, or both.

The use of properly designed head-lamps that incorporate two-filament lamps and that are equipped with but one focusing adjustment gives no indication of any necessity for more than this one adjustment. These head-lamps have now been in service for almost 2 yr. on one make of popular medium-priced car and on several others for a somewhat shorter period. An inspection of the head-lamp equipment on a number of cars of the make first referred to showed no indication of any trouble from the lack of a second adjustment on this type of head-lamp. The service manager for the Boston dealer

handling this car stated that, in all the company's experience with this head-lamp, difficulty in getting a good focusing adjustment was encountered in only one case. The evidence of this service manager is of unusual value, as he is a graduate of the Massachusetts Institute of Technology, served as an instructor at that institute after graduating, and has been connected with this service station for a number of years.

The acceptability of two-filament tilting-beam head-lamps equipped with but one focusing adjustment and designed to be insensitive to the vertical positioning of the filament has been demonstrated. In this demonstration a direct comparison is made between the beams from such a head-lamp with the filaments at (*a*) the design position, (*b*) raised 0.055 in. and (*c*) lowered 0.055 in., and the beam from an acceptable single-filament head-lamp with the filament at design position. The demonstration also shows that the tilt and the lower beam from the first head-lamp are satisfactory in each case. The purpose of this demonstration is to show that such a proposal as the use of a vertical adjustment should be based upon difficulties encountered in service and not upon theoretical considerations.

Various authorities, including the Society of Automotive Engineers, the Illuminating Engineering Society and the Bureau of Standards, favor the simplification of head-lamp adjustment and the approval of head-lamps with a single or no focusing adjustment. The Society of Automotive Engineers has adopted as recommended practice for head-lamp construction:

> The head-lamp should be designed so that not more than one focusing adjustment is necessary.

The 1926 Report of the Committee on Motor-Vehicle Lighting of the Illuminating Engineering Society includes the following:

> The depressible-beam system of headlighting advocated in the last report of the Illuminating Engineering Society Committee on Motor-Vehicle Lighting has been recognized by all States and is already being installed on about 30 per cent of the cars manufactured. The Committee reiterates its belief that controllable-beam systems offer the most promising means of ameliorating night driving-conditions on roads and regrets any action which will unnecessarily hamper the wider adoption of this system in proper form.
>
> One of the most difficult factors in improving conditions is the maintenance of equipment in satisfactory operating condition, and this improvement will eventually be furthered most effectively by simplification of all adjustments. Some two-filament devices are sensitive to certain variations in the position of the light sources, and when such variations are present the desired results cannot be obtained with only one focusing adjustment. However, other devices incorporate principles of design which minimize the effect of such variations and hence operate satisfactorily with only one focusing adjustment. Thereby the adjustment is left simple and within the capabilities of the average service man and motorist.
>
> The Committee shares the general belief that to secure the desired improvement in night driving-conditions, the guiding principle in headlighting development should be the eventual elimination of adjusting devices rather than their multiplication. The Committee feels that types of construction which minimize the effect of variations and obviate the necessity for complicated adjustments should be given every encouragement in the interest of public safety. This will give further stimulus to accurate manufacture of all parts of headlighting equipment and help to realize the desired lighting results most fully.

Head-lamps of the two-filament tilting-beam type and having both horizontal and vertical-focusing adjustments are difficult to focus properly. It is almost impossible to write simple focusing instructions that motorists in general will understand or be able to follow.

The vertical-focusing adjustment attempts to correct by compensation the inaccuracies in placement of filaments in electric incandescent lamps. Its use as an added adjustment is contrary to the first principle that should underlie every effort to improve headlighting, which is simplification of adjustment and more accurate construction of each important part.

It is possible to design head-lamps with a focal area instead of a focal point so that a satisfactory beam will be produced when using electric lamps, the filaments of which are out of position within the range of inaccuracy in the commercial product from 0.00 to 0.05 in.

Improvement in headlighting would be retarded if State laws were to require the vertical-focusing adjustment in addition to the horizontal adjustment, as this would lessen the incentive for head-lamp and electric lamp manufacturers to produce more accurate products.

The following quotation is taken from a letter addressed to the Massachusetts Registry of Motor Vehicles by the Bureau of Standards:

> Our present equipment, that is, single-filament lamps, has been approved on the basis of only one adjustment, that is, along the axis, and this adjustment has in a large majority of cases been sufficient to take care of the variation in filament location usually encountered.
>
> With a proper lens or reflector design it is possible to minimize the effect of variations in filament location and it is possible to secure satisfactory optical performance with only one focusing adjustment. Several of the new head-lamps which have lately come on the market are provided with only one adjustment and are very satisfactory.
>
> We, therefore, feel that every effort should be made to so design and build the two-filament equipment that the adjustment is made as simple as possible.
>
> While in some designs two focusing adjustments may be required, the vertical adjustment is, in a sense, a disadvantage because a slight movement of this vertical adjustment has a very marked effect on the beam, and it seems very doubtful whether the average garage mechanic can be expected to make the adjustments with the degree of accuracy required.

Reference in the last paragraph to the possible requirement of two focusing adjustments in some designs evidently refers to those which are particularly sensitive to filament positioning.

Focusing and aiming are different and distinct operations, and are performed with two different purposes in

view: to (*a*) alter the characteristics of the beam, and (*b*) direct the beam properly. The vertical-focusing adjustment has been advocated by its sponsors for three different purposes: (*a*) correction for vertical misplacement of filaments, (*b*) aiming of the beam and (*c*) variation of the amount of tilt between the upper and lower beams.

It is evident that the vertical adjustment may be used to correct for any vertical misplacement of the filaments due to inaccurate construction and thus alter the vertical distribution of light in the beam. It may also be stated that a change in the vertical positioning of the filaments results in an angular change in direction of the top of the beam, a change in the sharpness of the top cut-off, and a change in the definiteness and amount of tilt between the two beams. It must be evident, then, that the vertical adjustment cannot be used solely for one of these purposes without disregarding two others. If the adjustment were absolutely necessary for any one use it could not be used properly for either of the other purposes. If it be assumed that the additional vertical adjustment is required for the correction of filament displacement and the aiming of the beam, the drawing at the right in Fig. 3 shows the absurdity of such combined uses. The filaments are brought to the positions indicated by the two black spots and then are deliberately moved away again to aim the beam. Head-lamp mountings, which are made adjustable so that the aim of the beam may be changed as necessary, should be used for this purpose.

When the vertical adjustment is used exclusively for focusing, the beam may be made as nearly perfect as is possible with the equipment. When used for aiming alone, the beam is distorted if aimed to raise the top cut-off of a perfect beam which points downward. If the beam points too high, it is impossible to bring it down with this focusing screw. These results will vary with different head-lamps and electric lamps. In any case, however, worse results may be obtained than if the additional adjustment were not provided.

The Commonwealth of Pennsylvania has issued a tabular form, dated July 15, 1926, that shows that when head-lamps are focused and aimed perfectly, using various electric lamps, they may not set with their head-lamp fronts in the same vertical alignment. The change in the set of the head-lamps tabulated is so slight as to be undetectable by the casual observer. It may be expressed in a fraction of an inch by which the top of the head-lamp door is ahead or behind the bottom of the door. In 187 settings out of 200 given in this tabulation for single-focusing head-lamps, this variation would be no more than 3/16 in. for a 9-in. lamp door. In the worst case the deviation from the perpendicular was 3/8 in., or 2 deg. In all cases the deviation would be 3/16 in., or 1 deg., or less if the electric lamp were reversed. The alignment of the fronts of the head-lamps by such amounts, by using the vertical adjustment for aiming, does not justify a requirement of the addition of the vertical-focusing mechanism.

CONCLUSIONS

It has been shown that compliance with the intent of the State law necessitates such construction of head-lamps that their adjustment and care can be explained in a simple way, and that future development should be made in the direction of greater simplification of adjustment and better construction of head-lamp parts. Focusing offers the most serious obstacle to proper head-lamp adjustment in practice and every encouragement should be given to development in the direction of the elimination of all focusing adjustments. Certain statements have been made in this presentation about the use of *additional* vertical-focusing mechanisms, but it should be obvious that they are not meant to apply in the case in which the vertical-adjusting mechanism is substituted for the horizontal-adjusting mechanism and in which no provision is made for more than one adjustment.

It is hardly probable that the aiming adjustment can be eliminated under the present system of headlight control, but it is likely that the focusing adjustment will be eliminated. With such a development universally applied, it will be possible to so regulate headlighting that no operator will have a valid excuse for failure to comply with the law. To attain this desirable condition the manufacturer should give his serious consideration to more accurate construction and the designer should work toward less sensitive construction.

Failures of Electrical Equipment on the Road

By D. P. Cartwright[1]

Semi-Annual Meeting Paper

ABSTRACT

FAILURES of electrical equipment on the road are especially annoying, as the car owner's knowledge of electrical equipment is very meager and he usually is unable to diagnose the trouble and apply a remedy. Electrical apparatus is blamed for more than one-half the emergency-service calls. A consistent effort by the electrical-equipment and automobile manufacturers should be made to reduce this proportion. More dependable apparatus can be produced and the increased first cost to the purchaser of the automobile will be less than the sum of present maintenance and emergency-service costs.

Wear of electrical equipment is both mechanical and electrical. Movement of wires due to expansion and contraction wears the insulation; electrical stresses are constantly trying to break through the insulation that confines them to their normal paths, and bearings, brushes and timer-distributors are subjected to frictional wear. The knock, grind, squeak or unusual heat that prompts the owner to go to the service station for repairs to other parts of the car does not develop in electrical apparatus to warn him that a breakdown is imminent.

A few automobile clubs that render emergency service to members have classified road failures as to their causes. These are discussed and corrective measures suggested. In another year data will be available that will be definitely comparable and from which a method of reducing the number of failures of electrical equipment may be evolved.

FAILURES on the road are exasperating. They seldom select the time and place for their occurrence with any respect for the dignity of the passengers or the convenience of the owner. Good dispositions are sometimes soured and furious traits of character disclosed that friends did not know were dormant. Knowing smiles of passing motorists keep the blood at boiling temperature and induce facial contortions of rage. The picture of such an instance should be hung on the walls where designers, production managers, chief inspectors and others who have a part in the fabrication of the automotive vehicle pass frequently. Service managers in the field should be brought face to face with a life-size reproduction of this picture whenever a car is returned to the owner. Failures on the road would then be fewer.

Sometimes a failure results in a weary tramp to secure help and the account of it emphasizes the physical exertion. Sometimes the narrative dwells on the exorbitant towing-bill or the "highwayman" charge exacted by the expert who is summoned. These incidents often affect the pocketbook, and most owners resent long and loudly any expenditures that do not represent value received. A failure stopped a car 300 miles out on the veldt in South Africa. Help was 100 miles or more away. The owner decided that the cause of the trouble was in a certain part, removed it and took it back 300 miles to Johannesburg, where he was given a new part although the one he brought in was in good working order. He returned with the new part and some advice, but the new part failed to correct the trouble and another part was removed. This time he was lucky, for the fault was in it. The car manufacturer was asked to pay an expense bill, as the owner had received nothing of value other than experience, which he was very willing to do without.

Another owner, on a week-end trip with his family, was stopped by a failure. A village mechanic worked a day on the car without result. The owner and his family returned home on the train. Later he received word that the trouble had been found and the faulty part replaced. The dealer was notified by a lawyer that suit would be entered unless the owner was immediately reimbursed $85 for hotel expense, railway fares, and incidentals.

What is the effect of such instances and the narratives of them? They produce a vivid lasting memory of the roadside experience, a vow to buy no more cars of the same make, and a resolve to warn friends against the car that proved so costly or troublesome. Such advertising does not promote sales.

Causes of Electrical-Equipment Failures

A study of the emergency-service records of automobile clubs that have a road service indicates that a considerable percentage of failures on the road are due to the owner's carelessness or to his failure to maintain the car properly. Running out of gasoline accounts for as much as 8 per cent of the emergency calls. Tire replacements constitute from 7 to 40 per cent, although many of these would be eliminated by occasional simple inspections.

Failures of electrical equipment on the road fall into five general classes:

(1) Failure after a reasonable mileage of operation
(2) Failure due to neglect of maintenance
(3) Failure due to refusal of the car builder to purchase electrical apparatus of sufficient capacity and having the necessary stamina, and failure to install such equipment properly
(4) Failure due to faulty design, material or workmanship
(5) Failure due to climatic conditions

The car owner is seldom responsible for failures due to wear and tear. Very few owners know the functions and method of operation of the various electrical units. Without this knowledge, they are unable to determine when any unit should be repaired. The owner's fault is therefore passive in that he has neglected to have periodic inspections made by competent automotive electricians.

Electrical equipment wears both mechanically and electrically. Mechanical wear is limited mostly to bearings, brushes and timer-distributors. Whether a bearing should be replaced can be determined by ordinary me-

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chanical methods. It is usually made evident by the noise produced by the additional clearance or, in the case of ball bearings, by the rough surfaces of the balls and races. Whether the wear of commutator or brushes is extensive enough to require truing or replacing can be determined by inspection.

Difficulty of Detecting Electrical Wear

Electrical wear, however, can be detected only by the series test-lamp, the voltmeter, the ammeter, the Wheatstone bridge, the growler and the heavy-discharge test set. Very few garages and car-dealer service stations have even voltmeters and ammeters, and those that they have are seldom accurate enough to indicate pending electrical failures. The owner who depends on the usual service-station to prevent failures of the electrical equipment does not receive a service that will accomplish this result. Fewer failures from electrical causes would occur if the electrical apparatus were inspected by the skilled electricians and tested with the accurate instruments that constitute the personnel and equipment of the service station which specializes in electrical maintenance.

Electrical apparatus is subject to wear factors that are rarely taken into consideration. All insulated parts are under voltage stresses that break through when corrosion, moisture or oil reduces the resistance of the dielectric. The high-tension or secondary part of the ignition system especially is affected by these deteriorating influences. As the apparatus warms up while operating, expansion produces a movement of the wires within the insulation, and this movement is reversed when the engine is stopped and cooling and contraction follow. Armature windings are subjected to expansion and contraction wear and, in addition, to inertia and centrifugal stresses. The normal action of the battery is such that the wear factor alone limits its life to a fairly definite period. These kinds of wear, which cannot be detected by visual or mechanical inspections or by tests, lead the owner to wonder why electrical failures are so frequently the cause of his misfortune.

Failures Resulting from Owner's Neglect

Failures due to neglect of maintenance result from several causes. Insufficient lubrication usually develops generator or ignition-unit bearing-trouble on the road. The battery is, however, the unit that requires most attention yet is frequently neglected. When water is not added, the plates sulphate and then there are no lights for the drive home. Corrosion is permitted to form an insulating film on the battery posts and the engine will not start because the current cannot penetrate this film to reach the starting motor and the ignition coil. The charging rate is not increased in the winter to compensate for the longer hours the lights are used and the heavier duty the starting motor is called upon to perform, and the result is a call for a rental battery. Another reason for rental-battery calls is the discharge of the battery through the ignition coil when the switch is not turned off. A considerable percentage of failures due to these causes result in emergency-service trips to the owner's garage instead of to the roadside.

Formed terminals to which the wires are soldered have replaced connections that formerly were made by looping the wires around binding-posts or screws. These terminals are fastened securely with nuts and lock-washers, and road failures due to loose connections have been greatly reduced. A well made wiring-harness is now being used and the network of wires that formerly was productive of puzzling short-circuits and grounds has disappeared.

Effects of Insufficient Unit-Capacity

Offsetting these improvements that have eliminated many road failures is the tendency to install generators and batteries of insufficient capacity. The car in the $800 class requires practically the same current supply and battery capacity as the car in the $5,000 class. Each has the same lamp load and ignition current, and the current consumed by the starting motor is nearly equal, since the larger engine is, or should be, equipped with a more efficient starting unit.

A 6-volt generator with a normal capacity of 10 amp. is soon set up to 15 amp. if it can be made to produce that amount of current. The overload heats the unit beyond the maximum permissible temperature and a breakdown results. The battery that is too small overheats and disintegrates. Because of insufficient capacity it is quickly discharged and trouble follows. This lack of capacity is aggravated by an increasing tendency to add current-consuming cigar lighters, stop and spot lights, electric windshield-wipers, and gasoline gages, and other accessories. The owner of a car that is equipped with a generator that cannot be set up to 15 amp. for winter requirements usually decides, after a few roadside failures from this cause, to buy a car with ample generator and battery capacity.

All of the current consumed passes through the battery ground-connection. A No. 10 screw holding a copper terminal to a steel member is a sure source of failures on the road of starting motor, lights, ignition or generator. The vehicle builder can decrease the number of road failures by tinning the member where the ground-connection is made and by using a substantial bolt. Paint or rust will prevent the starting current of several hundred amperes from passing through the ground-connection, and trouble follows a flimsy installation of this kind.

Occasionally the engineering or manufacturing department of an automotive electrical-equipment manufacturer makes a mistake just as those departments of the vehicle manufacturer do. A bad design or a manufacturing fault can cause an avalanche of road failures. Usually these are of short duration, as a remedy is found and applied in production as well as to units in the field. One automobile club offered to alter without charge one of the electrical units on a certain model of a well-known car in its territory, as the club officials estimated that the expense of correcting the design or manufacturing fault would be less than the cost of service due to failures on the road.

How Climatic Conditions Affect Electrical Systems

Climatic conditions cause more trouble with batteries than failures in other electrical units. An electrolyte with a specific gravity of 1.300 is very satisfactory for a temperate climate but would shorten the life of the battery in tropical countries. Heat in tropical countries also tends to wear out the battery faster but this is offset by the lower charging-rate of the generator, which is permissible because less current is required for lighting and the periods of operation of the starting motor are short. Reverse conditions are encountered by the battery in temperate zones in cold weather, which accounts for the majority of the failures from this cause.

Data secured from two automobile clubs show that electrical trouble occasioned 53 per cent of all emergency calls during 1926. Average, minimum and maximum

TABLE 1—PERCENTAGE BORNE BY CALLS DUE TO ELECTRICAL TROUBLE TO ALL EMERGENCY ROAD-CALLS RESPONDED TO BY TWO AUTOMOBILE CLUBS EACH MONTH IN 1926

Month	Average	Minimum	Maximum
January	53.0	44.0	62.0
February	54.0	47.0	61.0
March	52.0	45.0	59.0
April	51.5	45.0	58.0
May	53.5	47.0	60.0
June	56.0	47.0	65.0
July	52.0	46.0	58.0
August	56.5	50.0	63.0
September	61.0	56.0	66.0
October	58.5	55.0	62.0
November	50.5	46.0	55.0
December	47.0	44.0	50.0

percentages of failures for which the electrical equipment was responsible for each month of the year as reported by the clubs are given in Table 1.

Battery failures varied from an average of 20 per cent for the months of May, June, July and August to an average of 32 per cent for December and January. These averages clearly indicate the heavier demand on the battery in cold weather and that the capacity of the battery and generator should be determined by winter demands and not those of the warmer months. The battery and generator that have ample capacity will operate with less heating effect in warm weather, which means a longer life and lower maintenance-cost.

Not all battery failures on the road are due to insufficient battery or generator capacity, but the increasing tendency to decrease the capacity will, without doubt, increase the percentage of battery failures. With failures of electrical equipment running to such high percentages, the builders of automotive vehicles must give serious consideration to the effect that these failures will have upon sales.

Starter and Ignition Failures Closely Related

Starting failures are somewhat less in warm than in cold weather. The average percentage for the year is 13.5; the average in summer, 13.0; and in winter, 15.5. Approximately one in every five emergency calls is charged to starting. This is a difficult failure to analyze and all of the trouble cannot be charged to electrical units; classifications of starting troubles as due to "cold engine," "carbureter," and "ignition," seem to absolve the electrical system from responsibility for the main reasons for inability to start the engine.

Starting motors are operated for such short periods that very few failures will be due to wear of this unit. Actual trouble within the starting motor will be but a small percentage of the total. An interesting fact is that the starting motor is operated an average of about once for each mile of car operation by most city passenger-car owners. The summer average is lower than this because of the longer trips, and the winter average is higher because the mileage after starting is less than in summer and also because the engine frequently fails to run until the starting motor has been operated two or three times.

Trouble in the mechanism through which the starting-motor torque is transmitted to the crankshaft is one of the causes of starting failures. Sometimes the mechanism jams, and at other times it fails to engage the flywheel. Damage to all types of starting mechanisms is frequently the owner's fault. An advanced spark at starting usually results in damage, as the starting motor is suddenly reversed by reverse rotation of the engine crankshaft. Reengaging the starting motor when the engine is rocking back is another cause of emergency calls.

One automobile club reported a battery-failure percentage of 19 and a starting-failure percentage of only 6. Two clubs reported battery-failure percentages of 6.5 and 8.0 and starting-failure percentages of 20.0 and 19.0. The reversal of the battery and starting-failure percentages in these cases and the close correspondence of the total percentages of 25.0, 26.5 and 27.0 indicate that battery and starting failures are so interrelated that the percentage of one cannot be considered without the percentage of the other.

Most owners make the mistake of operating the starting motor instead of using the crank or being towed when the battery is nearly discharged. The large withdrawal of current by the starting motor reduces the battery voltage to such an extent that the voltage at the ignition coil is insufficient to create a firing spark. The battery is blamed by some for this failure and starting is blamed by others. The lower the efficiency of the starting motor the more numerous will be the emergency calls, because the inefficient starting-motor withdraws a correspondingly greater amount of current from the battery, with a consequent still lower voltage on which the ignition coil attempts to operate.

Ignition Reliability Can Be Secured Cheaply

The wide variation in percentage of ignition failures is difficult to explain. It is also difficult to secure any definite data giving exact reasons for such failures. The high percentage of ignition trouble demonstrates that greater reliability can be secured by the expenditure of a very small amount for better ignition units. This vital part of the apparatus for the operation of the automobile is not, in general, being constructed sufficiently rugged to give trouble-free operation for reasonable periods.

Manufacturers of imitation parts produce very few electrical parts other than for ignition units. The decrease in the number of concerns making such imitation parts and the decrease in the volume of sales of imitation ignition-parts due to increased sales activities by the manufacturers of genuine parts prove that better ignition units should be produced.

Included in ignition failures are those caused by high-tension wires that are grounded or short-circuited where the insulation has been damaged, by storms that have grounded or short-circuited the high-tension terminals or affected the coil, and by spark-plugs that have become coated with carbon or in which the points have burned away, thus creating too wide a spark-gap.

The chief failures in the ignition unit are due to breaker-points wearing and requiring readjustment or replacement, to wear of the bearing or gears, to loose connections and occasionally to the breaking down of the condenser.

Fewer Failures in England than Here

Lighting trouble that is serious enough to require emergency aid is rare and the percentage of such calls varies from 0.4 to 2.0 per cent. Loose connections, broken wires and damaged insulation are charged, it seems, to the unit affected rather than to lighting, starting or ignition.

Of 5000 emergency calls answered by the Royal Automobile Club of London, electrical failures were responsible for 28.6 per cent. Ignition failures alone accounted for 21 per cent. In comparing this percentage with that

secured from domestic sources, consideration must be given to the fact that the magneto is the prevailing ignition-system in use in England. Five and one-half per cent of the failures were in the starting system and 2.1 per cent in the lighting system. The starting-system failures reported may include battery failures, as the latter are not listed. If this assumption is correct, the average percentage of combined starting and battery failures was 20 per cent less than those generally reported by our clubs. This percentage is substantially the difference between the London and domestic average of failures due to electrical equipment. A tag cautioning against the use of the starter in cold weather, that was attached to one make of car not long ago, might account for fewer starting and battery failures in England.

Failures of electrical apparatus should not be responsible for 53 per cent of the emergency calls. Better apparatus can be produced by the electrical-equipment manufacturers, but the cost will be greater. In the long run, however, the cost to the owner will be less, as the combined lower maintenance and emergency-service cost will be less.

THE COLLEGE, THE STUDENT AND BUSINESS

IF a boy is swerved away into business as soon as he leaves the preparatory school, it seems to me that he has not the maturity of judgment that will prevent him from becoming pretty well narrowed down to his business; the mere fact of 4 years of greater maturity counts tremendously so far as stability of his acquired interests is concerned. A boy in college should certainly get the opportunity for a mature and independent choice as to what sort of business or career he wants to go into. His mind should be liberated.

At college a boy has 4 years of such detachment from practical affairs as he will never have again. He exercises his brain on a great variety of subjects, developing all sides of it, and acquires a many-sided capacity to attack problems. The college boy has real genius in analyzing and arguing about general ideas. His analyses, too, are disinterested, because of his detachment. He has no practical axe to grind; a professional school student, or a man in business, if he takes up some subject of study, say psychology, does so, I have found, to exploit it for some immediate practical interest. He is thereby checked from envisaging the subject entire, its methods, its many-angled implications. Intellectualizing one's activities is a most precious asset in later attacks on pressing practical problems which, because of their urgency, often distort perspective. I am not sure that this is not what is meant by the vague phrase "mental training."

Last year some 300 business firms sent representatives to Yale to interview seniors, with offerings of some 600 different jobs. The business men are coming to the colleges to find their future executives. Is it that the business men cannot find the men they want outside the colleges because of the tremendous popularity of the colleges, because such men just happen to be in the colleges, or is it that the college gives them the type of training that will make them good executives later?

Business men have said to us,

> We want boys who have developed from their college training a restless curiosity, a critical attitude toward themselves and toward their jobs, a certain complex intellectual initiative.

They have said, furthermore, that on the whole they think that those boys who have devoted a large part of their attention to what these business men call the speculative or argumentative subjects are better prepared for the business world than those who have devoted themselves more or less to subjects that are capable of being answered "right" or "wrong," such as the exacter sciences, the mathematics and some of the technical subjects. The reason they give for this is that boys who have had the more speculative and more argumentative subjects are accustomed to look at the question from all sides. They are accustomed to criticize anybody's statements and, therefore, they get an attitude of mind that gives them intellectual initiative and that critical curiosity which seems to be so valuable.

The business men seem to prefer the ones who have taken a general course, rather than those who have taken a purely technical course. It is not only in a liberal-arts college that one may get the type of general education that I speak of; many scientific schools are attending more to the more general fundamentals, that will prepare the boys to acquire later, in business, the technical equipment needed, and acquire it rapidly. One should not, of course, belittle the exacter technical training; its value is tremendous, but it should not bulk too large in the general perspective.

INTELLIGENCE TESTS

I am rather skeptical about the possibilities of constructing specific tests of college men's abilities to enter any of the complexer professions or complexer business positions. In the Army we could by a 2-hr. test determine whether a man was a good apprentice or journeyman, or master worker as a wheelwright or an electrician, and the Army utilized the tests that we psychologists got up, but when one comes to such things as law or medicine or the complexer executive positions that involve such an interweaving of capacities, I doubt very much if we shall ever get any specific test that will enable us to determine in advance who will make the successful man in these particular things.

The "general" intelligence tests have proved themselves to be exceedingly informative things and, other things being equal, I think the man with high rating in general intelligence is likely to be equally successful in any one of a dozen things that he might undertake, excepting those that require special talents, like music.

What we should do in our vocational bureaus is to interview the students very carefully and ask them all sorts of questions. We should keep a fairly complete record of all their activities, their family background, their cultural and economic background, their previous educational preparation, what they have done on the athletic field and editorial boards, as well as in their studies, and place this information on a reference card.

Business should be able to give us what might be termed job analyses, such as, the different tasks set by different positions, the successive stages through which a person has to go, and studies of that sort. We in the college cannot give the students this information; it must come from the business world.

There are so many differences of opinion as to what mental discipline is. I believe, from a psychological or any other point of view, that it is one of the most important things that the college can give, but that that discipline so far as possible should be a self-discipline on the part of the boy, rather than an imposed discipline from without.—From an address by Dean Angier, of Yale, before Harvard Club of Boston.

Torsional Strength of Multiple-Splined Shafts

By C. W. Spicer[1]

Semi-Annual Meeting Paper *Illustrated with* Photographs and Charts

ABSTRACT

BECAUSE of interest which has developed in a previous paper by the author on the same subject, and on account of questions raised as to the nature of the deformation of splined shafts when the deformation is carried beyond the elastic-limit, the previous tests which were carried only a little beyond the elastic-limit of the specimens have been repeated and extended to the rupture point. Additional specimens typical of those commonly used for permanent fittings were also tested for their own characteristics and for comparison with the form of test-specimens that were used in the series of tests that were previously described.

As in the previous tests, the results show that the torsional strength of the multiple-splined shaft is considerably less than that of a plain round shaft of diameter equal to the base diameter of the splined shaft. However, the elastic-limit of a shaft supported by a hub member, as in the case of a permanent fitting, is considerably higher than in a shaft not so supported. Dimensional details of the specimens are stated, stress-strain curves are presented and a brief discussion of the results is included.

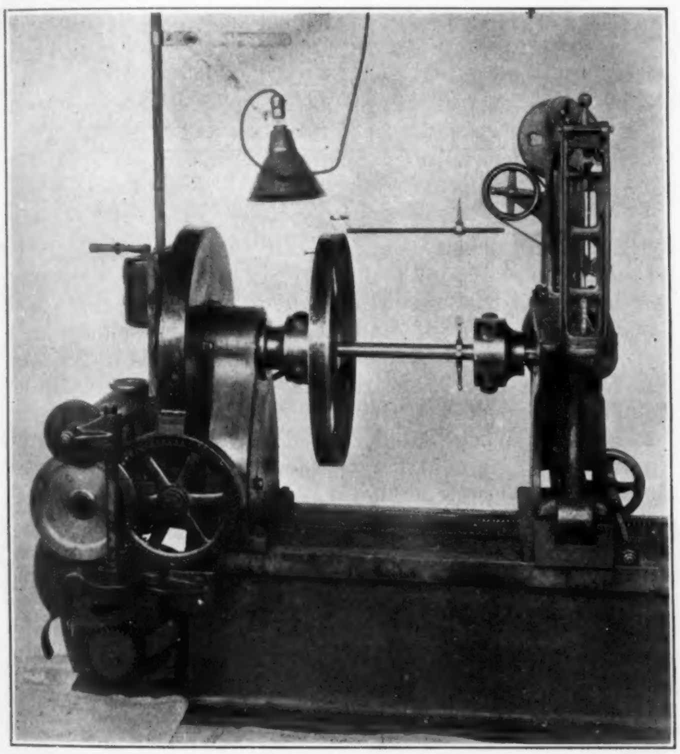


Fig. 1—Olsen Torsion-Testing Machine of 60,000 In-Lb. Capacity
A Specially Turned Pulley with Steel Measuring-Tape on the Rim Was Substituted for One with a Troptometer Arm

THE results of tests described in my paper on this subject[2] which was presented in 1921 were different from those that would have been expected unless one had given the subject careful analytical study. In conducting the tests at that time it was thought that it would not be worthwhile to extend the work much above the elastic-limit, as the elastic-limit is usually considered to be the permissible limit of stress in practice. It has since developed that considerable interest exists as to what form the stress-strain curves would take between the elastic-limit and ultimate-strength. This, together with improved facilities for conducting careful tests, led us to repeat the previous tests and to run the loadings through to the breaking-point. Also it was thought desirable to add other test-specimens illustrating the now

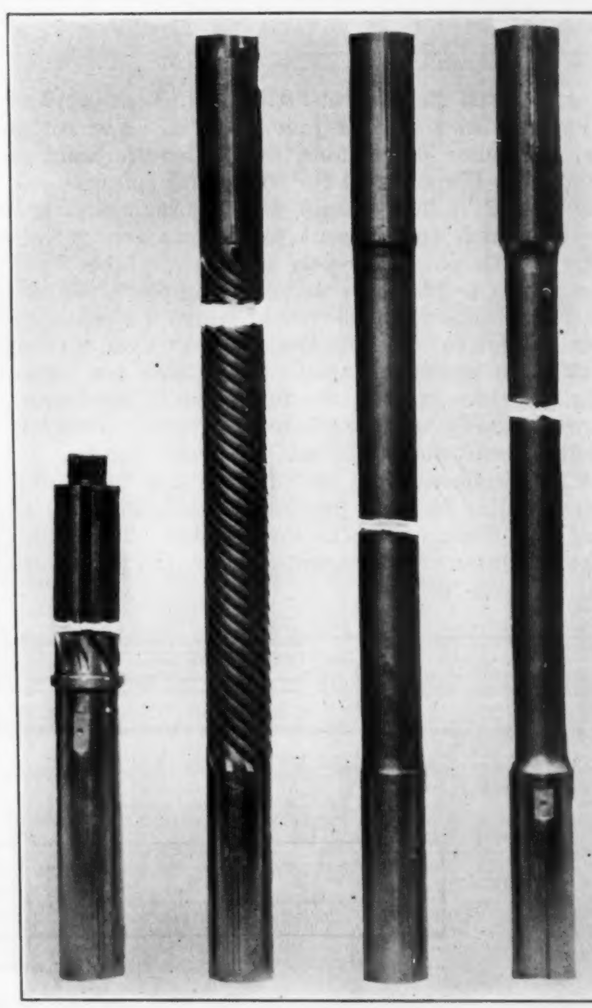


Fig. 2—Specimens After Test
One Specimen of Each of the Four Groups Is Shown

[1] M.S.A.E.—Vice-president and chief engineer, Spicer Mfg. Corporation, South Plainfield, N. J.

[2] See The Journal, February, 1921, p. 129.

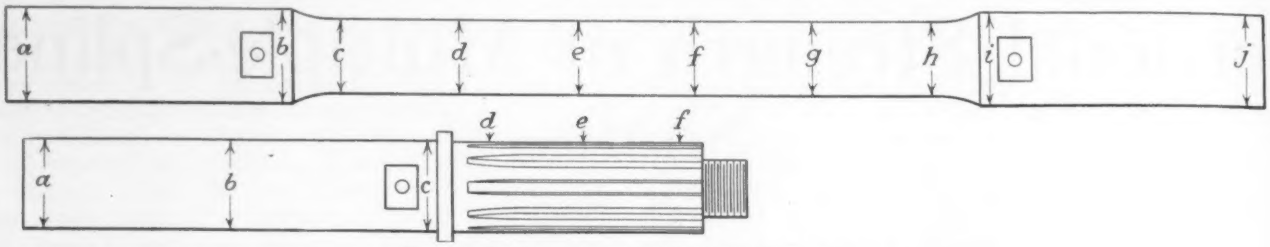


FIG. 3—DIAMETERS OF TORSION-TEST SHAFTS
Detail Dimensions of the Short Splined-Shafts (Upper View) and of the Plain Round-Shafts (Lower View) Are Given in the Table

Shaft		a	b	c	d	e	f	g	h	i	j	Brinell Diameter			Hardness Number 3000 Kg.
												End, Mm.	End, Mm.	Average, Mm.	
Large Round	6	1.6236	1.6235	1.5396	1.5395	1.5395	1.5395	1.5395	1.5395	1.6236	1.6237	4.000	4.050	4.025	226
	7	1.6235	1.6235	1.5396	1.5395	1.5395	1.5395	1.5395	1.5395	1.6235	1.6235	4.000	4.000	4.000	228
	8	1.6240	1.6240	1.5390	1.5390	1.5389	1.5389	1.5388	1.5388	1.6239	1.6238	4.000	4.000	4.000	228
	10	1.6236	1.6236	1.5391	1.5390	1.5389	1.5389	1.5389	1.5390	1.6237	1.6237	4.000	4.050	4.025	226
	11	1.6238	1.6238	1.5395	1.5394	1.5394	1.5394	1.5394	1.5393	1.6236	1.6236	3.900	3.900	3.900	241
Splined	12	1.6250	1.6249	1.6240	1.6238	1.6235	1.6232	1.6230	1.6230	1.6248	1.6251	4.050	4.100	4.080	221
	13	1.6252	1.6252	1.6250	1.6250	1.6250	1.6250	1.6250	1.6250	1.6250	1.6250	4.000	4.050	4.025	226
	14	1.6244	1.6244	1.6245	1.6244	1.6242	1.6240	1.6240	1.6240	1.6244	1.6245	4.100	4.100	4.100	217
	15	1.6240	1.6240	1.6232	1.6229	1.6228	1.6228	1.6225	1.6225	1.6242	1.6243	4.100	4.000	4.050	223
	16	1.6240	1.6240	1.6218	1.6220	1.6223	1.6225	1.6228	1.6228	1.6240	1.6244	4.000	4.100	4.050	223
Small Round	22	1.6240	1.6237	1.3150	1.3150	1.3150	1.3150	1.3149	1.3149	1.6236	1.6238	4.000	4.090	4.000	228
	23	1.6239	1.6238	1.3151	1.3150	1.3149	1.3149	1.3148	1.3148	1.6238	1.6239	4.000	4.100	4.050	223
	24	1.6240	1.6239	1.3156	1.3157	1.3158	1.3159	1.3160	1.3160	1.6237	1.6239	4.100	4.000	4.050	223
	25	1.6240	1.6240	1.3151	1.3152	1.3153	1.3152	1.3151	1.3150	1.6239	1.6239	4.000	4.000	4.000	228
	26	1.6240	1.6240	1.3145	1.3146	1.3147	1.3147	1.3148	1.3148	1.6238	1.6238	4.100	4.000	4.050	223
Short Spline	17[a]	1.6244	1.6244	1.6244	1.6243	1.6243	1.6243	......	......	......	......	4.000	.....	4.000	226
	18	1.6240	1.6240	1.6240	1.6241	1.6241	1.6241	......	......	......	......	4.000	.....	4.000	226
	19	1.6240	1.6240	1.6240	1.6240	1.6240	1.6240	......	......	......	......	4.050	.....	4.050	223
	20	1.6240	1.6240	1.6240	1.6241	1.6241	1.6241	......	......	......	......	4.050	.....	4.050	223
	21	1.6240	1.6240	1.6240	1.6236	1.6236	1.6236	......	......	......	......	4.000	.....	4.000	226

[a]Not tested.

commonly used permanent-fitting spline as applied to transmission and to axle pinion-shafts. For comparability, the spline dimensions, except length, were made the same for the short as for the longer splines.

The 60,000 in-lb. capacity Olsen torsion-testing machine on which the present tests were conducted was similar to the one previously used, except that one of the standard troptometer arms was replaced by a specially turned pulley, on the rim of which a steel tape was snugly wound to simplify the readings over all angles extending to several complete revolutions, as indicated in Fig. 1. Once started, the test on each specimen was run continuously until rupture occurred. Rotation of the testing head was at the rate of 90 deg. per hr.

The 20 specimens were ground to a fine finish all over and are similar to those previously used, with the addition of 5 specimens with the short spline. These include the short splines of permanent-fit type, the longer spline with the spline-cut "running-out" at both ends, large plain round shafts of a diameter about midway between the large and the small diameter of the spline shaft, and small round shafts of diameter equal to the small diameter of the splined shafts. The large round size was included because it represents approximately what is sometimes expected in the way of strength if the subject has been superficially considered only. The stress-strain curves show the contrast between the strength of these and the actual splined-shafts.

All the test-specimens were taken from the same mill-heat of steel and were still further selected by deep etching to assure, so far as possible, uniformity and complete absence of internal and external defects so that the results might be as uniform as possible. Analysis showed carbon 0.440, manganese 0.630, sulphur 0.034 and phosphorus 0.017 per cent for S.A.E. No. 1045 steel. The heat-treatment was to heat to 1625 deg. fahr. and

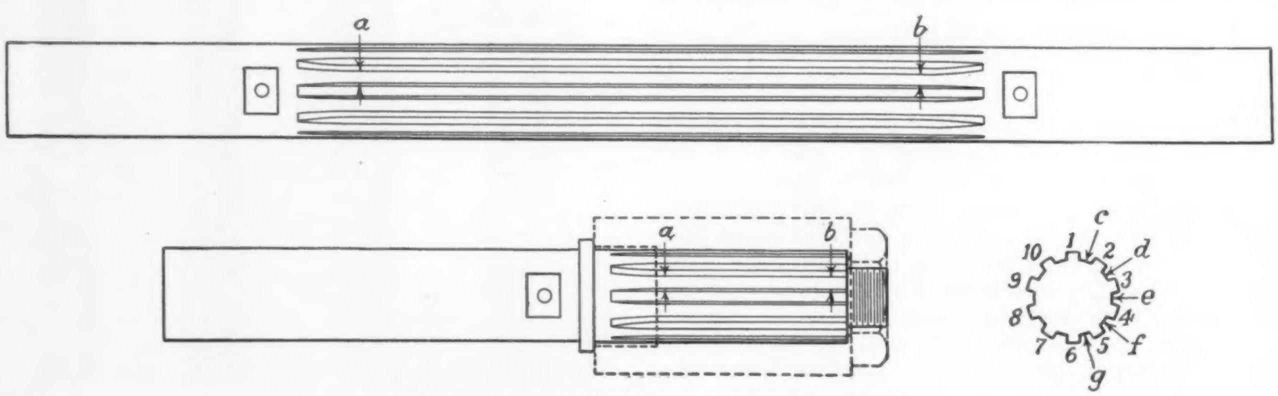


FIG. 4—THICKNESS OF SPLINES AND ROOT DIAMETERS
The Upper View Shows in Dotted Lines the Nut and the Hub Used for Applying the Load in the Testing-Machine and the Type of Shaft Designated as Nos. 17 to 21. The Lower View Shows the Type of Splined Shaft Designated as Nos. 12 to 16. Detail Dimensions for Both Types of Shaft Are Given in the Table on P. 741

cool in air; to heat to 1525 deg. fahr. and quench in water; and to draw at 1200 deg. fahr. for 30 min. Fig. 2 shows a specimen of each of the four shapes after breakage.

Details of Test-Specimens and Curves

Figs. 3 and 4 give details of all important dimensions and the hardness of the specimens just previous to placing them in the testing-machine. In the drawing of the short spline in Fig. 4, the form of hub and nut used for applying the load is dotted-in.

The curves in Figs. 5 and 6 represent the averages of the various groups of specimens. Fig. 5 shows the stress-strain curves to slightly above the elastic-limit which, in general, are similar to those shown in Fig. 4 of my previous paper[3]. The slight discrepancies between the previous and the present curves probably can be traced to the fact that, as stated in my former paper, some of the curves for that paper were plotted from figures "corrected" so as to make the curves directly comparable. In the present series, the dimensions were such that no corrections were required and the results are therefore more accurate than the former ones. The curves in the present paper plainly show, as did the previous ones, that the so-called Johnson elastic-limit of a splined shaft is substantially less than that of a plain round shaft of diameter equal to the base diameter of the spline. The Johnson elastic-limit is the point at which the unit increment of deflection per unit of load increase is 50 per cent greater than at the beginning.

Fig. 6 shows similar curves to those in Fig. 5, but to a smaller scale. It shows also complete stress-strain curves carried to the breaking-points of the specimens, the latter being drawn to a much shorter horizontal scale. It will be noted that, on the longer specimens, the testing-machine made between three and four complete revolutions before rupture of the specimen; in the case of the short spline, however, where the area subject to distortion was much more localized, failure occurred suddenly at a very much less total angular-distortion.

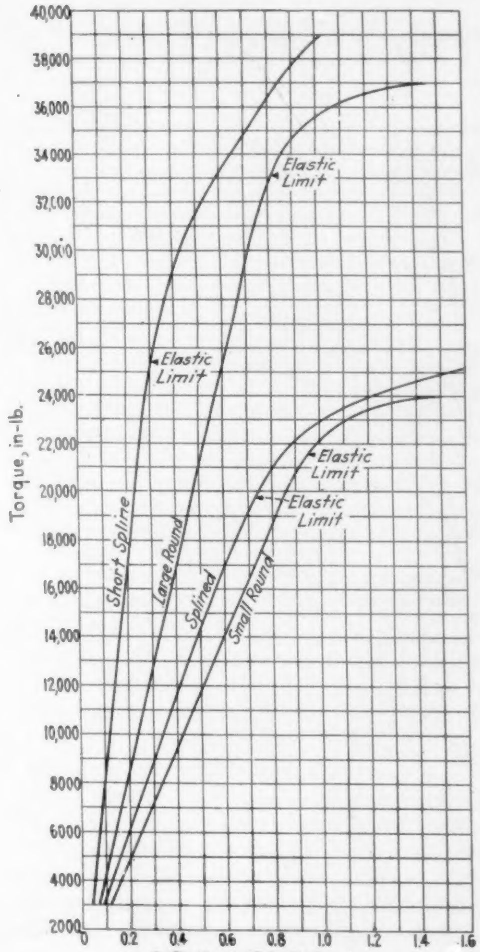


Fig. 5—Stress-Strain Curves
The Specimens Were Stressed to Just Above the Elastic Limit

It is interesting to note from these curves that, while the elastic-limit of the small round shaft is substantially greater than the elastic-limit of the splined shaft, for material of the ductility of the specimens used in these experiments the ultimate-strength of the splined shaft is much greater than that of the small round shaft. This

[3] See The Journal, February, 1921, p. 130.

TABLE FOR FIG. 4

Shaft	Thickness of Spline 1 a	1 b	2 a	2 b	3 a	3 b	4 a	4 b	5 a	5 b	6 a	6 b	7 a	7 b	8 a	8 b	9 a	9 b	10 a	10 b	Root Diameter c	d	e	f	g
12	0.2530	0.2540	0.2540	0.2535	0.2535	0.2530	0.2530	0.2530	0.2530	0.2530	0.2530	0.2530	0.2530	0.2530	0.2530	0.2535	0.2530	0.2530	0.2535	0.2535	1.3150 1.3165	1.3165 1.3166	1.3170 1.3170	1.3163 1.3168	1.3170 1.3165
13	0.2540	0.2540	0.2525	0.2525	0.2535	0.2540	0.2520	0.2520	0.2525	0.2530	0.2520	0.2525	0.2520	0.2525	0.2515	0.2520	0.2515	0.2520	0.2510	0.2510	1.3105 1.3110	1.3115 1.3120	1.3100 1.3115	1.3120 1.3130	1.3130 1.3125
14	0.2550	0.2550	0.2545	0.2545	0.2545	0.2545	0.2543	0.2540	0.2570	0.2570	0.2542	0.2542	0.2585	0.2545	0.2505	0.2530	0.2540	0.2540	0.2545	0.2545	1.3180 1.3170	1.3180 1.3160	1.3130 1.3120	1.3190 1.3175	1.3160 1.3140
15	0.2530	0.2530	0.2530	0.2535	0.2520	0.2525	0.2520	0.2505	0.2545	0.2570	0.2530	0.2535	0.2530	0.2535	0.2530	0.2540	0.2535	0.2540	0.2535	0.2540	1.3150 1.3160	1.3140 1.3160	1.3140 1.3160	1.3170 1.3190	1.3165 1.3175
16	0.2510	0.2520	0.2515	0.2520	0.2505	0.2515	0.2510	0.2520	0.2515	0.2523	0.2520	0.2526	0.2530	0.2545	0.2530	0.2540	0.2530	0.2540	0.2510	0.2520	1.3160 1.3210	1.3170 1.3210	1.3175 1.3210	1.3175 1.3210	1.3125 1.3170
17	0.2530	0.2530	0.2525	0.2525	0.2525	0.2525	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	0.2515	0.2515	0.2520	0.2520	0.2520	0.2520	1.3125 1.3115	1.3125 1.3115	1.3125 1.3113	1.3125 1.3113	1.3125 1.3125
18	0.2523	0.2520	0.2520	0.2520	0.2520	0.2520	0.2530	0.2530	0.2520	0.2520	0.2525	0.2525	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	1.3130 1.3125	1.3140 1.3125	1.3135 1.3125	1.3140 1.3116	1.3140 1.3130
19	0.2525	0.2525	0.2520	0.2520	0.2515	0.2515	0.2525	0.2525	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	0.2525	0.2525	0.2530	0.2530	1.3160 1.3150	1.3155 1.3140	1.3155 1.3140	1.3150 1.3140	1.3155 1.3140
20	0.2520	0.2520	0.2523	0.2523	0.2525	0.2525	0.2520	0.2520	0.2525	0.2525	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520	0.2525	0.2525	0.2530	0.2530	1.3160 1.3150	1.3160 1.3150	1.3160 1.3150	1.3165 1.3155	1.3135 1.3130
21	0.2530	0.2530	0.2525	0.2525	0.2530	0.2530	0.2525	0.2525	0.2525	0.2525	0.2525	0.2525	0.2525	0.2525	0.2530	0.2530	0.2530	0.2530	0.2526	0.2526	1.3155 1.3140	1.3145 1.3135	1.3125 1.3140	1.3150 1.3135	1.3145 1.3135

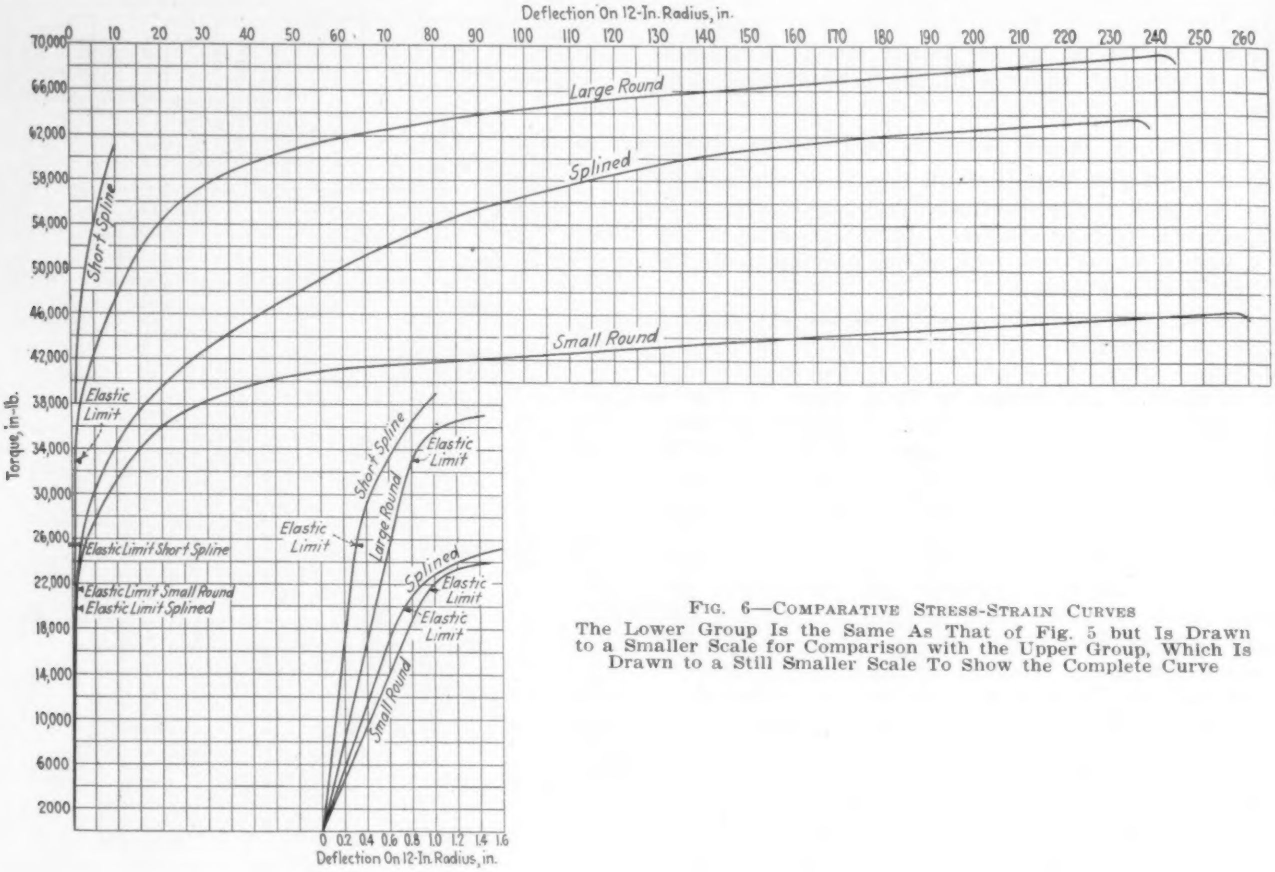


FIG. 6—COMPARATIVE STRESS-STRAIN CURVES
The Lower Group Is the Same As That of Fig. 5 but Is Drawn to a Smaller Scale for Comparison with the Upper Group, Which Is Drawn to a Still Smaller Scale To Show the Complete Curve

difference undoubtedly would be proportionately less if the shafts were made harder so that the elastic-limit more nearly approached the ultimate-strength.

Analysis of Deformation and Elastic-Limit

When applying a torsional load to a shaft of any symmetrical form it is evident that the deformation will be greatest in the outer fiber and that, for any given amount of stress, the deformation will become less and less down to zero at the neutral center of the shaft. Therefore, when the outer fibers are stressed to their elastic-limit, the fibers nearer the neutral center are only partly so stressed.

The reason the elastic-limit of the splined shaft is less than that of a plain round shaft of diameter equal to the base diameter of the splined shaft evidently is that the disposition of the metal in the splines is such as to add very little torsional strength to the shaft. At the same time, when under load, the distortion of the outer fibers will be about the same for a given angular-distortion as though the shaft were of plain circular cross-section of diameter equal to the large diameter of the spline. From this it is evident that the outer fibers of the spline will reach their elastic-limit due to angular distortion before the elastic-limit has been reached at the base of the spline which is nearer the neutral center of the shaft, the difference being substantially in ratio to the average radius of the spline from the center of the shaft in relation to the base of the spline. However, continuing the distortion beyond the elastic-limit, with material as ductile as was that used in these tests, the splines assume a spiral form and gradually come more and more into tension, whereby a portion of the strength of the cross-section of the splines in tension is added to the torsional resistance of the solid part of the shaft, thus providing, beyond the elastic-limit, a combined tensional and torsional strength which exceeds the plain torsional strength of the small plain shaft. Again, if the splines are supported as in the case of the permanent fitting so that the splines are in more nearly direct shear from the beginning of the load application, the shearing-strength of the splines is added to the torsional strength of the body of the shaft, thereby increasing the elastic-limit, as indicated by the curves, very substantially.

The laboratory work in connection with these tests was supervised by my co-worker, G. L. Tarbox[4].

[4] M.S.A.E.—Experimental research engineer, Spicer Mfg. Corporation, South Plainfield, N. J.

The Problem of Brake Adjustment

By F. W. Parks[1]

Semi-Annual Meeting Paper *Illustrated with* Charts and Photographs

ABSTRACT

After emphasizing the seriousness of the problem of brake adjustment, the author outlines how it came to exist, discusses who is responsible for its solution, analyzes how four-wheel brakes have affected it, mentions its legal phases and states what has been done to solve it.

The brake-testing machine described is an electric-motor-driven transmission-dynamometer. The gage reading is the same as would be obtained if an endless strip of concrete roadway having a coefficient friction of about 0.75 were pulled under the wheel of a motor-vehicle while the brake is applied. The number of pounds of braking force is indicated by a gage. Charts show the relationship which exists between the weight of the vehicle, the total retarding-force and the rate of deceleration which the retarding force will produce on any particular vehicle, and their use in connection with the data obtained with the testing-machine are explained. A system of grading motor-vehicles with regard to brake performance is presented also. In conclusion, the advantages of these means of attaining correct brake-adjustment are enumerated.

Admitted to be one of the most serious mechanical problems confronting the industry, the problem of brake adjustment has been cumulative in its nature until it is now in a chronic state and is of national importance. It has been precipitated by several causes such as good roads, faster driving-speeds, the most dense motor-population of any country in the world and a growing brake-consciousness on the part of the public and of the law-enforcement authorities.

Motor-vehicles have been provided for 22,000,000 or more people in the United States, and the greatest mileage of good roads of any country in the world is available on which to operate them. In many States, mere ownership of the vehicle has endowed the owner with the right to drive it on the public highways. For the most part, our best engineering talent has been devoted to making these 22,000,000 vehicles *run*, at greater speed, more quietly and more cheaply. Little attention has been devoted toward *stopping* these vehicles. From seven to nine gages and instruments are installed on the average passenger-car, but all deal with *running* the car and not one of them is for the purpose of indicating its ability to *stop*. Until recently, no means has been provided for determining whether the vehicle can be stopped within a reasonable distance, and what constitutes a reasonable distance for stopping has been hazily defined. In other words, we have had no science of braking forces whatever, but have muddled through and have paid the price in human lives. Only 10 per cent of the vehicles on the road have even reasonably adequate brake-adjustment. Hence, the problem is to develop a science of braking forces so that we can improve the stopping performance of 90 per cent of our 22,000,000 motor-vehicles. This problem exists because we have now developed such acceleration for motor-vehicles that we must perforce provide adequate and safe deceleration.

Adequacy of deceleration implies sufficient quantity of retarding force. Safety implies proper distribution of the total retarding-force, as well as sufficient quantity. As a preventive of a certain class of accidents, enough brake capacity properly distributed seems too fundamental to permit argument. The problem also exists because we have had no means of measuring braking forces. There can be no science in any subject until means for measurement are developed. We have not known until recently the relationship that exists between the weight of the vehicle, the retarding force which stops it, and the rate of deceleration which this retarding force will produce on that particular vehicle. It was impossible to show that relationship until the retarding force could be measured and the relationship shown mathematically, but this has now been accomplished.

In the past, braking systems have been in the personal-impression stage. Owners and mechanics have described brake performances in terms of personal impressions. State laws regarding brake performance, where they exist, reflect this same personal-impression stage of development. The advertising of cars, brake-linings and the like, reflects the same situation. Absurd claims have been made in national advertising, claims that were physically impossible of fulfilment, yet few have been sufficiently informed to appreciate this fact. The speedometer was developed to eliminate personal impressions as to speed and distance, and now we must eliminate personal impressions as to brake performance and adopt scientific means of measurement.

Whose Is the Problem?

The solution of the braking problem does not rest wholly on any one branch of the industry. The responsibility rests equally on engineering, production, service and sales. We have tested the four-wheel brakes on cars at several factories, after the cars had passed inspection and were ready for shipment. In no instance were the brakes properly equalized or had they proper ratios of performance. In many cars, the total available braking-force present did not equal that of a good two-wheel-brake car. In no instance did the methods used give uniform results. On some cars, as high as 70 per cent of the braking force was found to exist on one side of the car.

The appalling fact is that probably more than 50 per cent of such cars are delivered to customers without further brake-adjustment. So many cars are sold in communities of less than 10,000 population that the dealer's facilities, knowledge and training prevent him from improving on the factory adjustment of brakes. We have tested the dealer's work also, and find that usually he has made little or no improvement, even when he has attempted to do so. Therefore, the practice of wishing the job of brake adjustment onto the country dealer is a grave neglect of manufacturing responsibility. So the responsibility lies first with engineering, to design

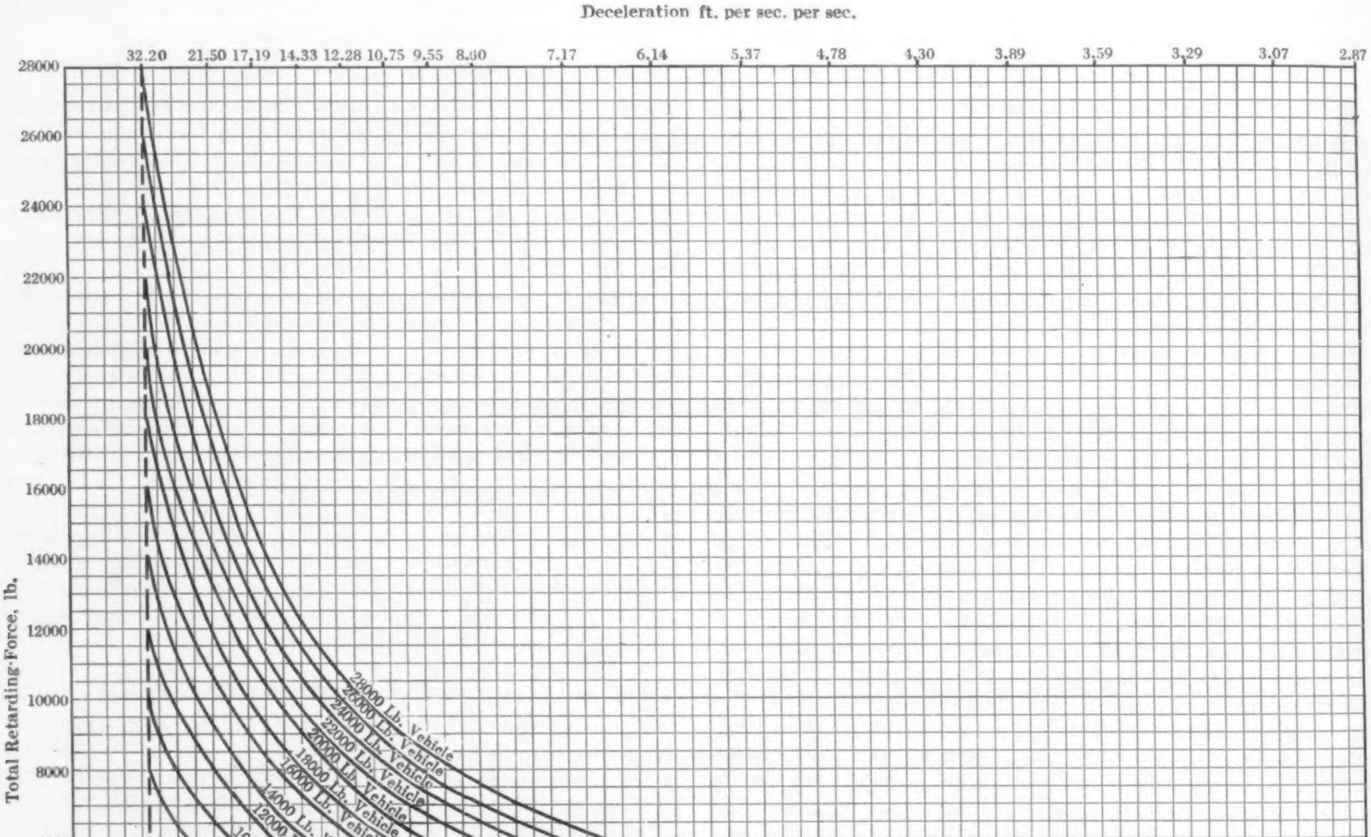
[1] Sales manager, Cowdrey Brake Tester Organization, Fitchburg, Mass.

into the car a proper braking-system. Engineers should establish standards of practice and performance, and should know what is possible of attainment with the braking system as designed.

Experimentation shows us that, while some systems are properly designed, others have hook-ups that do not perform as they are designed to perform. One make of car intended for 55-per cent braking-force on the rear wheels and 45-per cent on the front wheels showed by actual test that the larger part of the total braking-force was on the two front-wheels. We also found one other case where adequate front-wheel retarding-force could not be produced, due to faulty design. The adjustment simply was not provided. We have found many types of brake adjustment of so coarse a nature as to prevent close equalization. Apparently, it has not been recognized always that brake adjustment should be of a micrometer capability, since minor changes of adjustment at the critical point create wide changes in braking effort.

Production departmental responsibility is perfectly clear. Obviously, all cars shipped to dealers should leave the factory with brakes adjusted to a predetermined standard of brake performance. At present, this requirement is being lived up to in but few cases, even though money is being spent for its apparent accomplishment. It may seem that standard lever-positions, standard rod-lengths, standard clearance and the like, will effect uniform results on all cars produced, but that is not true. Unless uniform results are obtained, the existing standards are not performing their function and are of questionable value.

Brake-drum eccentricity has not been thoroughly studied in all factories with reference to its effect on braking effort. In some cases, 0.015 in. has been allowed for eccentricity. The Society has promulgated a toler-



Selected Speeds, m. p. h.																
10	3.3	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5
15	7.3	11	17	23	28	34	39	45	51	56	62	68	73	79	84
20	13.4	20	30	40	50	60	70	80	90	100	110	120	130	140	150
25	20.9	31	47	63	83	94	109	125	141	156	172	188	203	219	234
30	29.3	45	68	90	113	135	158	180	203	225	248	270	293	315	338
35	40.9	61	92	122	153	183	213	244	274	305	335	365	396	426	457
40	53.3	80	120	160	200	240	280	320	360	400	440	480	520	560	600
45	65.9	102	152	203	253	303	355	405	455	506	557	608	658	708	780
50	83.5	125	188	250	303	375	438	500	563	625	688	750	812	875	938
55	101.0	151	227	303	379	454	530	606	681	757	833	908	984	1060	1135
60	117.4	180	270	360	450	540	630	720	810	900	990	1080	1170	1260	1350

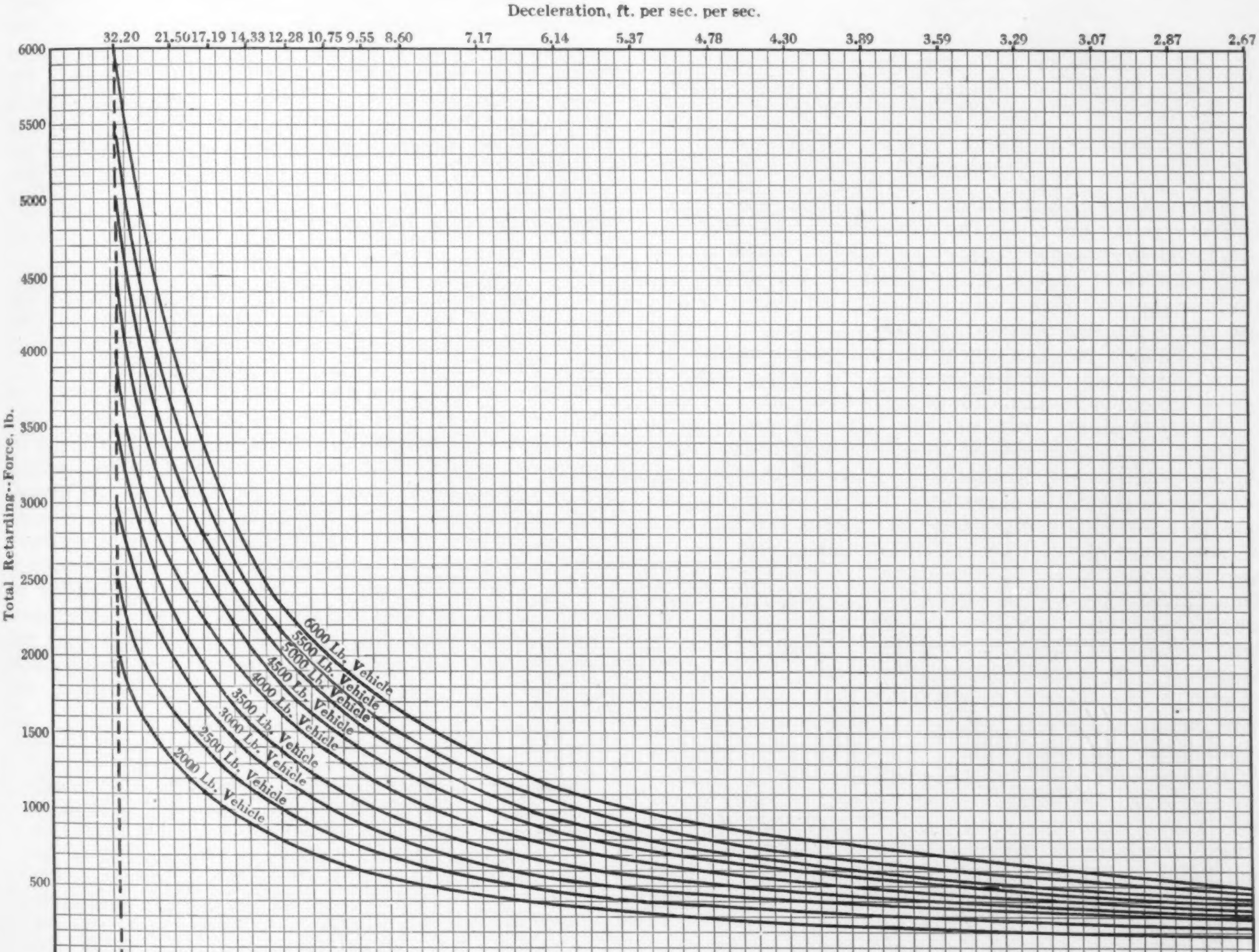
Stopping-Distance, ft.

FIG. 1—BRAKE-ADJUSTMENT FOR PASSENGER-CARS AND LIGHT MOTOR-TRUCKS
By Using the Chart As Described the Relationships between Motor-Vehicle Weight, Total Retarding-Force and Deceleration of the Vehicle Can Be Determined

ance of 0.015 in. for brake-drum eccentricity for drums of 16 and 17-in. diameter and 0.010 in. for drums of 15-in. diameter or less. We believe this tolerance too generous. Our experience to date prompts the suggestion to the Society that reconsideration be given to these tolerances. On a vehicle of say 3000-lb. weight, this tolerance will produce a variation of 200 lb-in. braking-effort in one complete revolution of the braked wheel. With such a variation, the wheel may readily lock in the same position at each brake application, thus ruining the tire, and it is impossible to equalize brakes where this condition exists.

The foregoing example explains the requirement in a brake-testing machine for slow-speed operation, so that such a variation during a complete revolution can be noted. Also, it explains certain service cases of chronic inability to equalize by the conventional hand-pulling or floor-skidding methods which do not disclose eccentricity. But suppose the engineering department has designed a proper braking-system and has established proper standards of practice, and suppose also that the production department is shipping all cars uniformly adjusted to perform to these standards. What comes next? Obviously, the production department must have used some sort of measuring device by which to define its practice and by which to accomplish performance that is up to the definition.

In proper sequence, then, the dealers' service-organizations must follow the same practice and must use the same standard of measurement for brakes. It is a well known but lamentable fact that many motorists have transferred their patronage from dealers' service-stations, because of dissatisfaction over brake-adjustment, and have sought out the specialized brake service-station



Selected Speeds, m. p. h.																
10	3.3	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5	4.0
15	7.3	11	17	23	28	34	39	45	51	56	62	68	73	79	84	90
20	13.4	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
25	20.9	31	47	63	83	94	109	125	141	156	172	188	203	219	234	250
30	29.3	45	68	90	113	135	158	180	203	225	248	270	293	315	338	360
35	40.9	61	92	122	153	183	213	244	274	305	335	365	396	426	457	487
40	53.3	80	120	160	200	240	280	320	360	400	440	480	520	560	600	640
45	65.9	102	152	203	253	303	355	405	455	506	557	608	658	708	760	810
50	83.5	125	188	250	333	375	438	500	563	625	688	750	812	875	938	1000
55	101.0	151	227	303	379	454	530	606	681	757	833	908	984	1060	1035	1213
60	117.4	180	270	360	450	540	630	720	810	900	990	1080	1170	1260	1350	1440

Stopping-Distance, ft.

FIG. 2—BRAKE-ADJUSTMENT FOR MOTORCOACHES AND HEAVY MOTOR-TRUCKS
By Using the Chart As Described the Relationships between Motor-Vehicle Weight, Total Retarding-Force and Deceleration of the Vehicle Can Be Determined

in the hope of obtaining better brake adjustment. During Brake Safety Week in Boston, Mass., in the spring of 1927, free brake-tests were made with our equipment. It was a startling fact that practically every well-known dealer in Boston was unfavorably advertised to us in regard to brake service by one or more disgruntled influential customers. Service today implies keeping the customer "sold" on his car. Since his own life and the lives of his family and of the public depend on his brakes, it is of vast importance that his car be kept to its maximum brake-performance.

Brake hook-ups are not stable mechanisms; once adjusted, they do not remain so indefinitely. Hence the necessity for dealer adoption of standard practice. The sales force needs enlightenment on this subject. Why confuse and mislead the customer into expecting the impossible? Why claim to "stop the car on a dime"? Why boast of ability to "push your head through the windshield"? Yet salesmen use such terms as these when demonstrating a car to a prospect. Why not substitute for such inaccuracies and exaggerations an exact definition in terms of feet of distance within which to stop from a speed of 20 m.p.h.?

How Four-Wheel Brakes Have Affected the Problem

All know the public attitude toward four-wheel brakes and how, in its ignorance, the public demanded them. An awakened brake-consciousness caused the public to feel that four-wheel brakes meant greater brake safety, and the demand for them became so insistent that few cars are left in the two-wheel-brake class.

The danger point of unequalized brakes has not yet been determined definitely, nor has the proper ratio of brake-force distribution. Both these functions may vary with each design of car, but one condition seems to be firmly fixed in the minds of laymen as well as engineers. All apparently concede that, with four-wheel-brake systems, there should be reasonably good cross-equalization, but the distribution to the front and to the rear in terms of percentage of total brake-force is apparently open to argument and is too controversial for discussion here. Some of us have had occasion to learn that many four-wheel-brake cars operating on the highways have no better brake-performance than has a good two-wheel-brake car. We have found many car owners who failed to see the advantage of four-wheel brakes over their former two-wheel brakes but, in testing such cars, the reason was that, due to lack of proper adjustment, the four-wheel-brake car was really only a two-wheel-brake car so far as braking effort was concerned. If we endeavor to retard one force by the application of four other forces acting in the opposite direction, we have multiplied the possibility of error in adjustments over that of the old condition of using but two retarding forces.

The "sliding-on-the-road" method does not give any measure of front-wheel-brake performance. Jacking-up the wheels and testing by hand is also very inaccurate for the following reasons:

(1) Jacking-up the car removes the weight from the bearings. If the bearing is worn, there is a change in concentricity of brake-drum and brake-band, or of brake-drum and brake-shoes, which introduces an error

(2) When testing by hand, few men can pull on an automobile wheel with the same power throughout the day

(3) Few men can apply the same strength in pulling the right wheel that they can exert in pulling the left wheel, because most men are right handed and can pull most strongly on the left wheel. Hence, when a mechanic thinks that two wheels are equalized for a given pedal-pressure based on his strength estimate, the wheels usually are not so equalized

(4) No man can pull more than 10 to 20 per cent of the total brake-capacity of a wheel, and we have proved that, if two brakes are equalized at a fraction of their total capacity, it does not follow by any means that they are equalized at their maximum capacity

(5) High spots, caused by eccentric brake-drums and the like, can be determined only by revolving a braked wheel slowly through a complete revolution. Pulling the wheel by hand does not disclose high spots. Instead, the mechanic obtains a confusion of static and dynamic frictional effects

Four-wheel brakes seem to have precipitated the problem of brake adjustment by magnifying the need for adequate measuring means, so that the vehicle can be tested under road conditions as nearly as possible. Because of the added complication of four-wheel brakes, more road testing has been required. The time loss and the financial responsibility to the car owner and to the public which this increased road-testing has produced accentuates the need for the development of a method which eliminates road testing.

The Legal Phase

It would be foolish to attempt to predict under what laws we shall be building and operating motor-vehicles 5 years hence insofar as brake performance is concerned, but a glance into the past is illuminating. Years ago, a builder of carriages sold a vehicle having a defective shaft which had been puttied and painted over. The purchaser was injured in a runaway accident caused by the breaking of the defective shaft. He sued the builder and recovered heavy damages. Representing the transition from the horse-drawn to the motor-vehicle, a decision was rendered in the Federal Court for the Northern District of Ohio in February, 1927, against a prominent builder of motor-trucks who was sued by the driver of a truck made by this builder. The driver was injured in an accident and sued the builder, alleging that the producer was negligent in making and selling a vehicle equipped with defective brakes. In his opinion, the Judge declared that:

> If the maker of an automobile or other product places it on the market to be used without inspection by purchasers, when it is reasonably certain that such use will endanger life and limb if the article is negligently made, then it is to be regarded as a thing of danger for which the maker's liability is not confined to the immediate purchaser and he is not absolved from the duty of due care in the making and selling because his company bought its parts of a reputable maker. An automobile negligently constructed falls within the same class as poisons, explosives and noxious foods, which are by their nature inherently dangerous.

This recent court decision brings home to the builder of motor-vehicles the possible legal responsibility for properly adjusted brakes on vehicles when they leave the factory. The fact that this decision was rendered by a Federal Court makes it all the more far-reaching in its significance. There have been other decisions of a similar nature in our courts. The point of all of them seems to be that a manufacturer who is guilty of negligence, or even failure to anticipate that a product is likely to be used in a manner that will endanger life and

limb, is liable to any user who may happen to be hurt, regardless of the presence or absence of contracts.

What Is the Solution?

The procedure needed to solve the problem of brake adjustments is to

(1) Develop a science relating to brakes
(2) Apply the science relating to brakes to the individual product at the factory
(3) Adopt standards of braking practice and performance to the vehicle being produced
(4) Ship all vehicles only after a known, predetermined brake-performance has been ascertained
(5) Adopt standards of brake-performance measurement so that brakes can be described in known terms
(6) Insist that dealers' service-stations be advised of these standards of practice and performance
(7) Require that dealers use the same means of measurement for maintaining the vehicles in their care up to predetermined standards

As to the steps already taken to solve the problem, our experimental work has not been conducted for the purpose of designing a new and novel type of braking system but has, instead, consisted of an attempt to devise a method and means by which to obtain maximum performance from braking systems as commercially furnished on the car. As a result, ours is the first company that actually has measured at the braked wheel the retarding force which stops the car, and to have shown mathematically the relationship which exists between the weight of the vehicle, the total retarding-force, and the rate of deceleration in feet per second per second which this retarding force will produce on any particular vehicle. Figs. 1 and 2 show this relationship, and show

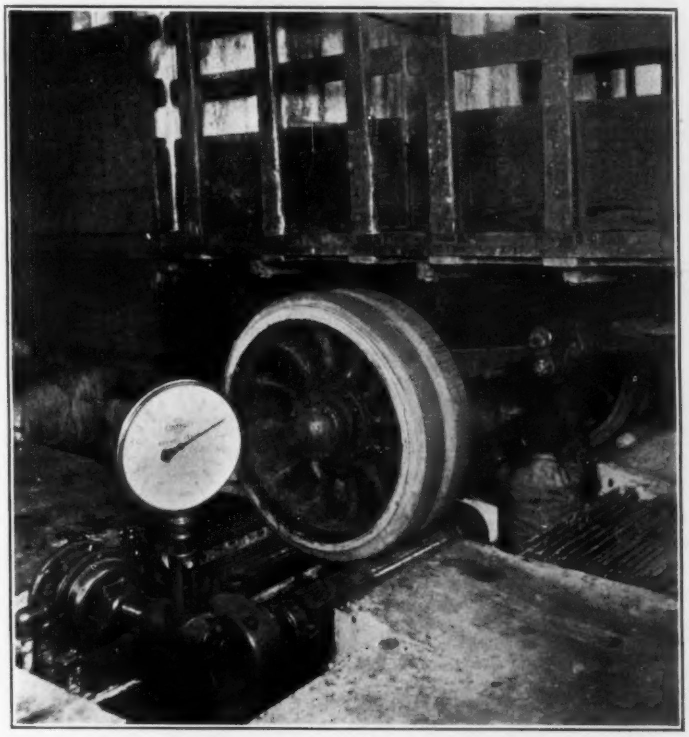


Fig. 3—Brake-Testing Machines in Operation
The Set-Up of the Brake-Testing Equipment for Motorcoaches and Heavy Motor-Trucks is Shown

also the stopping distance in feet from any selected speed with a given rate of deceleration. A clean, dry, smooth, level, cement roadway is assumed. All curves

Fig. 4—Passenger-Car and Light Motor-Truck Brake-Testing
A Machine Similar to That Shown in the Foreground Is Located under Each of the Four Wheels, the Vehicle Being Over a Pit To Provide Accessibility for Brake Adjustment

begin at the point at which the deceleration equals the value of gravity. This requires a coefficient of friction of unit value between the tire and the road. Present motor-vehicle design and present-day road-surfaces make the attainment of a unit value for the coefficient of friction highly improbable.

The curves shown in Figs. 1 and 2 are derived from the equation $F = m\ a$, that is, force equals mass times acceleration, and we have

$$F = (W/32.2)\ d \qquad (1)$$

where

d = the deceleration in feet per second per second
F = the retarding force, in pounds
W = the weight of the vehicle and its load, in pounds

Two of the quantities in equation (1) are known. The value of the force of gravity is fixed and the weight of the vehicle is stated by the builder. For passenger-cars and light motor-trucks, Fig. 1, add 300 lb. for gasoline, oil, water, spare tire, and the driver's weight; for motorcoaches and heavy motor-trucks, Fig. 2, add 500 lb. These allowances are sufficient for all practical purposes for most vehicles of the classes named. Additional weight should be allowed, however, in the case of vehicles which carry more than the ordinary amount of accessory equipment. Since the two unknown quantities of equation (1) are the total retarding-force and the deceleration, if one of them is assumed or is *measured accurately*, the other can be obtained from the chart. The following examples will serve to illustrate the method of using the two charts.

For Fig. 1, assume (*a*) that the total weight of the vehicle is 5000 lb., being 4700 lb. for the vehicle and 300 lb. for the load allowance, and (*b*) that the stopping distance from a speed of 20 m.p.h. is 30 ft. Locate (*a*) on the corresponding horizontal scale of Fig. 1 and follow the vertical line from that point to its meeting with the curve representing (*b*). From that point follow a horizontal line to the left, and the retarding force needed to produce such a stop will be found to be 2250 lb., as specified on the vertical scale.

For Fig. 2, assume (*a*) that the total weight is 16,000 lb. and that (*b*) the stopping distance from a speed of 20 m.p.h. is 40 ft. The same procedure as that described for Fig. 1 will show the retarding force needed to produce such a stop to be 5500 lb., as specified on the vertical scale. Conversely, a total retarding-force can be assumed and the procedure carried out in a reverse manner, thus locating a stopping distance in feet, from any specified speed, on the horizontal scale.

TABLE 1—GRADING OF MOTOR-VEHICLE BRAKE-PERFORMANCE FROM AN INITIAL SPEED OF 20 M.P.H.

Stopping Distance, Ft.	Comment[2]	Grade
	Four-Wheel Brakes	
15 to 16	Commercially Perfect	*A*-4
16 to 18	Excellent	*B*-4
18 to 20	Good	*C*-4
20 to 25	Fair	*D*-4
25 to 30	Poor	*E*-4
Over 30	No Longer in the Four-Wheel-Brake Class	*F*-4
	Two-Wheel Brakes	
30 to 32	Commercially Perfect	*A*-2
32 to 35	Excellent	*B*-2
35 to 40	Good	*C*-2
40 to 45	Fair	*D*-2
45 to 50	Poor	*E*-2
Over 50	Vehicle Unsafe	*F*-2

[2] The table refers to service brakes only, with the clutch disengaged. A clean, dry, smooth, level, cement roadway is assumed. The hand-brake should not rate poorer than Grade *E*-2.

BRAKE-TESTING MACHINES

We have built 19 different models of brake-testing machine, with which we have made thousands of motor-vehicle brake-tests. From this broad experience of our own, coupled with other data from reliable sources, and following conference with recognized authorities, we have established the grading table of motor-vehicle brake-performance shown in Table 1. In suggesting this grading table, we are adhering to the practice already established by the Bureau of Standards and adopted by several States, that all brake performance be interpreted as from an initial speed of 20 m.p.h. We also concur with the resolution adopted by the Eastern Conference of Motor-Vehicle Registrars, that all brake tests shall be made using an instrument especially designed for the purpose and capable of calibration by the Bureau of Standards or by the Underwriters' Laboratories, rather than to use the method of measurement from a painted line across the road, which is admittedly grossly inaccurate. At least two instruments which comply with the foregoing requirement are already on the market, and are commercially satisfactory for the use intended. They are much more convenient to use than is the method of measurement from a painted line across the road, and are far more accurate.

Our brake-testing machine, shown in Figs. 3 and 4, is an individual electric-motor-driven transmission dynamometer. The gage reading is the same as would be obtained if an endless strip of concrete roadway, having a coefficient of friction of about 0.75, were pulled under the wheel while the brake is applied. The gage does not indicate torque but does indicate pounds of braking force. The electric motor supplies power to the rolls on which the wheel rests, through a cycloidal gear-train and, as the brake is applied, more load is thrown on the motor. The gear-train and its casing then attempt to revolve around the major-axis centers in direct proportion to the braking effort. This tendency to revolve is opposed by a lever, and the amount of the opposition is indicated on a scale graduated to show pounds of road-pull. The sum of all the braked-wheel readings is the force, F, in the familiar formula $F = (W\ /\ g)\ a$, in which a represents acceleration. So far as we know, this is the first successful attempt to measure on a commercial as well as on a laboratory basis the retarding force that actually stops the car.

METHOD OF STANDARDIZING BRAKE-ADJUSTMENT

Suppose that a four-wheel-brake car which weighs 3500 lb. and has mechanical brakes is to be standardized for brake adjustment, so that it will stop within 20 ft. from a speed of 20 m.p.h., which corresponds to a deceleration of 21.5 ft. per sec. per sec. The brakes are to be adjusted so that 60 per cent of the braking force will be at the rear and 40 per cent of this force will be at the front. This will require a total retarding-force of 2350 lb. according to the chart in Fig. 1. Distributing 60 per cent of this force to the two rear-wheels gives 705 lb. on each; and distributing 40 per cent on the two front-wheels gives 470 lb. on each. If we then test this vehicle for stopping performance with a standard decelerometer, we are assured that the car will stop within 1 ft. or so of 20 ft. from a speed of 20 m.p.h. on any clean, dry, smooth, level, cement roadway, if the same pedal pressure as was employed during adjustment is reproduced.

Conversely, by using the chart in Fig. 1 in a reverse manner, if a similar car has a total-retarding-force reading on the gage of 2350 lb., we know that this car will stop within 20 ft. but the car may not have its braking force properly distributed.

The total braking-force determines the stopping distance, but the distribution determines how the car will swerve while stopping. For example, suppose a 300-lb. braking-force is found on the left front-wheel and a 640-lb. braking-force on the right front-wheel, and that the rear wheels each have a braking force of 705 lb. Then the car will swerve to the right, although it will stop within 20 ft. from a speed of 20 m.p.h. as before. Or again, suppose a 300-lb. braking-force is found on the left front-wheel and an 875-lb. force on the left rear-wheel; while a 640-lb. force exists on the right front-wheel and a 535-lb. force on the right rear-wheel. The total braking-force is still 2350 lb. and it is equally distributed on the two sides of the car. The car will stop within 20 ft., from a speed of 20 m.p.h., and will not swerve in either direction because of the mechanical couple which exists around the center of gravity. The right front-wheel tends to swerve the car to the right, while the left rear-wheel, by the same excess amount, tends to straighten-out the car's course. Thus, from the gage readings on the machine, it is possible to predict the stopping distance, the direction that the car will tend to slue, if it does slue, and the amount of retarding force present with reference to the full amount required for maximum performance. It is possible also to detect eccentric brake-drums or greasy brake-bands. These machine tests eliminate road testing of a car and are more valuable than road testing or floor testing, as well as requiring far less time.

Advantages to the Dealer

From the dealer's viewpoint of service, it is highly desirable that road testing and floor testing a car be eliminated. The financial responsibility and loss of time incident to road testing customers' cars is too well known to require explanation. Floor testing also takes time, interferes with the movement of other cars, delays other employes, and introduces an accident hazard. Customers dislike to feel that their tires are being abused by either of these methods, or that mechanics in greasy overalls are driving their cars to test brake adjustment.

To the dealer, the investment in brake-testing machines is profitable if he is doing a large enough amount of brake adjustment. His labor costs and the number of "come-backs" are so reduced, in addition to the elimination of road testing and floor testing, that he has but to maintain his present flat rate to the customer to make a good profit. During a recent demonstration, a certain four-wheel-brake car was adjusted by a mechanic who used our testing-machine for the first time on this car. The brakes had just been relined and were to be adjusted. Without knowing that he was being timed, the mechanic completed his work in 20 min., obtaining a proper total retarding-force and the specified distribution of braking force to the front and to the rear. For this particular make of car, the usual charge to customers for this operation is on a basis of 2 hr. In brake-service stations using our equipment 7 min. is not an unknown record for this operation of adjustment only. Mechanics who have used the equipment for a few weeks become very well satisfied with the information it furnishes them. They are no longer groping and guessing; instead, they know definitely when adjustments are made properly.

Pedal Pressure

No discussion of this nature could be complete if the subject of pedal pressure were ignored. It is a part of the science relating to brakes. For laboratory and experimental purposes, a pedal-pressure gage is necessary to correlate pedal pressures with retarding force, deceleration and vehicle weight. But such a gage is of questionable value to the service man because, when he receives the vehicle, pedal pressures are presumably determined and fixed. He needs only to adjust for a predetermined pedal-position, from which proper pedal-pressure will follow on account of the design.

Application of Brake-Adjustment Standards

Regarding the detailed information necessary for the application of standards of brake practice on the production line and in the service station, we have found by experience that brake-drums and brake-shoes must be held to close limits if uniform results are to be obtained. We believe that our method of testing makes possible the elimination of equalizers on mechanical brakes. No doubt equalizers were first incorporated into braking systems in the hope that they would perform up to their name. They were installed for the purpose of attempting to equalize two unmeasured forces; but, unfortunately, equalizers do not always equalize and, with mechanical brakes, far better results often can be obtained without them, now that a means of measurement is available, and a much more stable mechanism will result if equalizers are eliminated.

The cost of installing in a motor-vehicle plant the necessary brake-testing equipment for this suggested program is of small financial importance, when the time and labor that can be saved are considered. The usual procedure is to assemble internal brake-shoes or external brake-bands as one of the final operations of axle assembly. By setting these brake-shoes or brake-bands to a given clearance, determined by feeler gages, against a dummy brake-drum of normal correct size and by assembling rods and levers on the chassis to proper lengths and angles, no other operations are required until the finished car reaches the end of the assembly line or final inspection. Up to this point the braking system has been assembled with mechanical precision according to standards of design. However, due to the variations of size and position, which are allowed by working tolerances, the forces developed by the operation of the braking system vary. If the car is shipped in this condition, it has been proved that there is non-uniformity of braking effort, and the performance is unsatisfactory and unsafe.

If at this point the car is tested on a brake-testing machine and the last final touch of adjustment is made, then it leaves the plant with brakes equalized and the retarding forces properly distributed according to any predetermined standard. In several cases this operation is being performed in production in 1 min. or less, with a machine and a man to operate it at each wheel of the vehicle.

For production, the question is often asked if satisfactory brake-adjustment can be obtained without some method of removing high spots from brake-linings. This practice is already in vogue in several plants and should be universal. Two general methods are employed. One is to run-in or to burn-in the brake-lining after complete car-assembly. The other is usually referred to as a burnishing operation on each brake assembly separately be-

(Concluded on p. 753)

Specification-Writing for Petroleum Lubricants

By M. R. Schmidt[1]

Semi-Annual Meeting Paper

ABSTRACT

ALL large users of petroleum lubricants are endeavoring to reduce to printed form their individual ideas of what the lubricants they want should contain and what their physical and mechanical properties should be. The lubricants manufacturer finds, however, that anarchy prevails among the requirements and that the technique of writing the specifications is distinctly amateurish.

One method followed is to analyze a satisfactory lubricant and embody the results in the specifications, but the specifier does not know that the product is the best for his purpose and does not possess the facilities for accurate analysis and the ability to determine the pertinent from the irrelevant factors. Another method is to select from a number of analyses and specifications items that seem important and incorporate them in the writer's specification. The result calls for a non-existant hybrid that may be impossible to produce.

A third method, and the only proper one, is to make a comprehensive study of each lubrication problem and summarize the results in the specifications. This is the method followed by the larger manufacturers of lubricants and, to some extent, by the larger consumers. Such studies show that narrow limits of viscosity, flash-point and other properties are not necessary in oils and that exact soap-percentage, oil-viscosities and consistencies are not essential in greases.

Two underlying principles in specification-writing are that they should (*a*) describe fully the product desired so that the manufacturer can supply it and (*b*) enable the purchaser to determine whether the desired product has been supplied.

Numerous examples are given by the author to show that many specification writers are lamentably ignorant of the characteristics that are and are not relevant, of the nature of materials and of the limitations of analysis and test methods. Incorporation in specifications of a statement that, whenever possible, tests are to be made by the latest methods approved by the American Society for Testing Materials will avoid much uncertainty. If limits are fixed for quantities that are not determined by these methods nor covered by standard analytical practice, the specification should give in workable detail the method to be used or should make reference to a publication containing a description of it.

A SUITABLE subtitle for this paper might be The Present Dismal State of the Art of Specification Writing. The extent to which this indoor sport is indulged in is amazing, but the technique for the most part is distinctly amateurish. Motor-car manufacturers, railroads, public-service corporations, street-railways, machinery manufacturers, State highway departments, municipal governments, State Governments, and various branches of the National Government, all are endeavoring to reduce to printed form their individual ideas of what lubricants should contain and what their physical and chemical properties should be. The manufacturer of lubricants sits at the center of this tangled web. From all directions he receives demands to make slight changes in established products, so that they may come within the prescribed ranges. He finds, moreover, that among these requirements anarchy prevails; that few customers are agreed on the essentials of even so simple a product as an engine oil; that one plant requires a certain percentage of resin in its soluble oils, while another, half a mile away, absolutely refuses to approve any soluble oil containing resin. The manufacturer knows, also, that slight changes often involve added manufacturing costs, and that these are reflected in advanced prices to all.

How Specifications Usually Originate

Let us inquire, for a moment, how specifications usually originate. By far the easiest method of writing specifications is to analyze a satisfactory lubricant, to the extent of the ability of the plant laboratory, and to embody the results of the analysis in the specifications. By analysis is meant, of course, both the usual physical tests, such as gravity, flash, pour-test, viscosity, melting-point, and color, and the chemical determination of the various constituents. Obviously, specifications drawn up in this way have two serious defects: First, the specifier does not know that the product he is using is the best for his purpose or, all things considered, the cheapest. His experience is likely to be limited and his opportunity for experimentation small, since production cannot be interfered with. Second, the value of the specifications in securing what is desired depends entirely on the accuracy and completeness of the analysis and on the ability to sift out pertinent from impertinent items. Proficiency in either of these lines presupposes a wide acquaintance with lubricants in general, and especially with the connection between composition and properties; but such information ordinarily does not reside in the usual plant laboratory or purchasing department. A variant of this procedure, in place of analyses, is to adopt without critical scrutiny information supplied by salesmen. Specifications drawn up in this way frequently betray their origin by their surprising definiteness of detail, particularly with reference to refinery operations.

A second method of drawing up specifications may be termed the "eclectic method." The specification writer reviews a number of analyses and specifications that appear to have some connection with the problem in hand, and then chooses an item here and an item there as he deems them important. The result is usually a non-existent hybrid which, in the case of oils, may combine a certain low pour-test with an impossibly high flash-point, a certain viscosity range with an unattainable carbon-test, and so on. In the case of greases, the specifications may call for a lime-soap grease which must have the properties of a fiber grease, or for a fixed soap-percentage which is incompatible with the desired consistency or with the melting-point specified.

[1] Lubricating department, Standard Oil Co. of Indiana, Whiting, Ind.

Principles and Right Method To Follow

The third method of composing specifications, which is the only legitimate method, is to summarize the results of a comprehensive study of each lubricating problem. When such studies are made, it will often be found that narrow limits of viscosity, flash-point and other features are not necessary in oils, and that exact soap-percentages, oil viscosities and consistencies are not essential in greases. Moreover, service tests will reveal that good lubricants frequently possess characteristics which cannot be expressed in figures or otherwise reduced to writing.

This last method of arriving at the pertinent characteristics of a lubricant is the practice adopted by the larger manufacturers of lubricants, and, to some extent, by the larger consumers. The lubricants makers must keep in daily touch with the performance of oils and greases in every conceivable kind of service, and the large consumers are financially able to study their lubricating problems as part of their research programs. Often the manufacturer and consumer combine their forces, information and equipment, with results that are advantageous to both.

To arrive at the principles which should underlie all specification writing, it is necessary to consider the primary purposes of these documents. First, they should describe fully the desired product so that the manufacturer can supply it. Second, they should make it possible for the purchaser to determine whether the desired product has been supplied. In short, they must provide accurate characterization and protection. Hence, all clauses in specifications must be pertinent and must be enforceable.

"Straight-Run" Clause Useless and Unenforceable

Examples of irrelevant provisions in specifications are seen every day by lubricants companies. One such provision that is seen frequently is the "straight-run" clause. This requires that a lubricating-oil must not be a blend of two or more oils but shall consist of a single continuous fraction from the lubricating-oil stills, and that after treating, filtering and other processing, it shall meet all the physical and chemical tests of the specification without other additions or adjustments. Such a requirement is equivalent to demanding that brass of a certain chemical composition shall be made by reduction of a natural ore of copper and zinc without any additions to the product from the smelter, or that an alloy steel shall be turned out direct from the ore. Obviously, neither metallurgists nor petroleum refiners can work under such limitations. If oils having viscosities of 200 and 300 Saybolt sec. are regular products, intermediate viscosities will be obtained by mixing them. No refiner could afford to make separate runs in his stills to obtain a viscosity of 225 sec. for one motor-car company and a viscosity of 275 sec. for another company. Nor would either of these companies be willing to pay the prices entailed by small-scale manufacture of such special products.

This is not all. Let the refiner distill a batch of oil with a viscosity of 225 sec. until 50 per cent has passed through the condenser, mix the distillate with the half that remains in the still, and finish the mixture in the usual way. Obviously, the new product is no longer "straight-run," but how does it differ from the original oil? And how would a laboratory set about determining the method of manufacture? This "straight-run" fetish therefore also violates the second principle of specification writing; it is not enforceable, and it gives the buyer no protection.

Some standards recently proposed for transformer and electric-switch oils contained a demulsibility test, which specified the time of separation of the oil after churning with water, salt solution and caustic-soda solution. If there is one substance with which a transformer oil must never come in contact, that substance is water. If moisture enters the oil, even to an extent which does not impair its brilliance, the dielectric strength is reduced to a small fraction of the original value and the oil is unfit for use until it is reconditioned. Hence the appositeness of a demulsibility test is not at all evident.

Other instances of irrelevant requirements are low cold-tests in oils which will never be subjected to cold, low Conradson carbon figures in oils which will never be subjected to high temperatures, low precipitation numbers in transmission and gear oils, and high demulsibility in oils for internal-combustion engines.

Material Specifications That Are Not Enforceable

Most material specifications covering the kinds of fats or fatty acids to be used in greases are prime offenders against the enforceability rule. After a fat has been saponified and its soap mixed with lubricating-oil, the separation of the fatty acids presents no great difficulty, but their identification to a degree of certainty which would warrant rejection of a product is almost impossible, and when mixtures of fats are used the problem is quite insoluble. It is possible, by mixing fatty acids, to duplicate the physical and chemical constants of almost any other fatty acid. The question is further complicated if the unsaponifiable portion of a fat or wax is necessary for identification, since this part is separated with the lubricating-oil and is therefore unavailable for examination.

Among the most ancient and futile of such material specifications is the demand for horse fat as a soap base. Probably at one time horse fat was obtainable in fairly large quantities, although it never has been one of the major packers' products. Nowadays, due chiefly to the laudable efforts of the automobile manufacturers who call for it in their greases, horse fat is almost as scarce as rattlesnake oil. If grease makers depended today on horse fat for their soap supply most of them would have to go into other lines of manufacture and their customers would use very little grease. As for positively distinguishing horse fat from all other fats, after it has been worked up into grease, we may well doubt if any laboratory would be so rash as to go on record as having accomplished the feat.

An extreme example of an unenforceable requirement was recently seen in some specifications for a steering-gear grease in which the oil was to consist of 80 per cent of cylinder stock and 20 per cent of other lubricating-oil having a pour-test of —25 deg. fahr. How the purchaser proposed to separate these ingredients from each other was not disclosed.

Ignorance of Limitations of Analysis Revealed

Aside from violations of the major principles of pertinence and enforceability, specifications frequently contain statements that reveal only slight acquaintance with elementary physics and chemistry and a disregard for the limitations of analysis. In many cases limits are set that are far beyond the reach of the most skilled analyst. For instance, a request was made recently for a transformer oil with an iodine value of not more than 0.1. It is well known that determinations of the iodine values of

petroleum oils are more uncertain and subject to greater experimental error than those of any other class of oils, and the expected error in this case would certainly be much greater than the value sought. The writer of this specification evidently never had made an iodine determination but probably knew that it had something to do with unsaturation and deemed it best to keep the unsaturation as small as possible.

Not long ago a refinery was asked to supply an oil in which a moisture content of not more than 0.001 per cent would be guaranteed. The reply was that such a guarantee might be made if the prospective customer would outline his method for determining the percentage. The method proved to be a distillation of a mixture of the oil with benzene or xylene. The appearance of a haze in the condenser was regarded as a trace of moisture; a trace, in analytical chemistry, was acknowledged by all to be 0.001 per cent; therefore, haze in the condenser was taken as 0.001 per cent. The logic is delightful. Unfortunately, even when benzene or xylene has been dried with metallic sodium and all the glassware has been baked, a haze still appears in the condenser. It finally transpired that the customer was seeking to guard against moisture because the oil was intended for transformer use. Seemingly he never had heard of a breakdown test.

One of the largest manufacturing companies in Detroit permits an acidity of 0.3 milligram in engine oil but demands zero acidity in its compounded cylinder-oil. Needless to say, it never has received a cylinder-oil of zero acidity, and never will. Every cylinder stock shows a slight organic acidity, and the same is true of the so-called "acidless" tallow oils or lard-oils for which the specifications call.

A large metal-refining plant in the Middle West complained about the very corrosive nature of a red engine-oil, alleging that it contained 3 per cent of sulphuric acid. Investigation showed that the chief chemist had determined the total content of sulphur in the oil in an oxygen bomb and had calculated his result in terms of sulphuric acid, as the latter was the only sulphur compound he could think of as likely to be present. Incidentally, he had carelessly shifted the decimal point one place to the right. Several of the forms in which sulphur may occur in petroleum oils were mentioned to him and he was assured that, of all these, sulphuric acid is the least likely to be found. Refiners cannot afford to leave sulphuric acid in their products, which are stored in steel tanks, pumped by iron and steel pumps through steel pipe and filled into steel barrels or tank cars or into tin cans. This equipment, representing investments of many millions of dollars, is protected as carefully as possible against all forms of corrosion, and the most elementary precaution is to see that the products handled are not themselves corrosive, regardless of any obligations to the customer. Happily, this old bogey, sulphuric acid in lubricating-oils, is rapidly being forgotten, along with the terrors of cracked gasoline.

Do Not Know Nature of Materials

It is found that specification writers are totally ignorant of the nature of the materials they attempt to describe. For example, standards for a certain transmission grease called for the incorporation of 17 to 20 per cent of lead stearate in a specified oil, the product to have a pour-test of 20 deg. fahr. and to flow to the gears at zero temperature. The grease manufacturer made up such a mixture and found it to have a melting-point above 190 deg. fahr. The customer then relented by permitting the use of any lead soap. A modification of the previous formula again failed to meet the pour-test, although by a much smaller margin. Finally, a sample of a competitive product was secured which, the customer asserted, met all his requirements. It proved to have the proper pour-test but contained only half as much soap as demanded. The next step was to check up on the method used for determining lead soap. It was very simple; the sample was washed, the lead converted into oxide and weighed as such or as chromate, and the percentage of lead soap calculated from this result. No attempt, it seemed, was made to confirm the presence of any fatty-acid radical. The competitive grease contained 10 per cent of lead soap instead of 20 per cent, but sufficient uncombined litharge was added to give a total lead-content corresponding with the larger figure. As the pour-test was greatly influenced by the amount of soap present, it was easy by this means to meet the specification at all points, provided this worthless method of soap determination was used.

This is only one of many cases in which those skilled in inorganic analysis but unable to handle the more complex organic methods cause needless delays in arriving at the truth, advocate specifications which are impossible to meet and fail, in testing their purchases, to protect their employers. The additional skill needed is not an unreasonable requirement. Determination of the fatty acids in a grease containing lead soap is a comparatively simple process but it cannot be done by means of a porcelain crucible and bunsen burner alone.

Ample evidence exists that those who draw up specifications for certain automotive companies do not know the difference between a lime grease and a soda grease. For instance, a purchaser desired a steering-gear grease containing a given percentage of soda soap. A product conforming with the requirements in every particular was supplied but was rejected. At the same time a sample of grease regarded by this buyer as entirely satisfactory was obtained from him and was found to contain only lime soap. In another case the customer called for a lime grease but objected to it on the ground that it was not fibrous enough. Such ignorance is appalling and tends to make lubricants manufacturers regard the average specification as a mere nuisance and a cause of delay in reaching the heart of any lubricating problem.

Possible Accuracy of Tests Misunderstood

Difficulties often arise from a misunderstanding of the possible accuracy of testing methods. We have received complaints that certain shipments of oil were 0.5 sec. low in viscosity, and complaints about 5 deg. difference in flash-test are frequent. It need scarcely be pointed out that a skilled operator, when making duplicate determinations on the same sample, cannot consistently obtain such precision, and it is futile to expect it when comparing the results of different operators in different laboratories.

Much uncertainty will be eliminated if each specification states that, whenever possible, tests are to be made by the latest methods approved by the American Society for Testing Materials. These methods are so thoroughly accredited that no excuse remains for retaining obsolete procedures and terminology. Yet we still find many references to a cold test, cold set, or flowing-test, instead of pour-test, and sometimes the test must be made in a test-tube instead of in the standardized jars. The use of small porcelain dishes in taking flash-points is another survival, which we trust will soon be extinct. Obstinate

clinging to antiquities is no longer regarded as a sign of wisdom but, rather, of mental torpor.

If limits are fixed for quantities that are not determined by the American Society for Testing Materials method, nor covered by standard analytical practice, the method to be used should be given in the specification in workable detail, or reference should be made to a publication containing it.

MacMichael Viscosimeter Not for Greases

An increasing number of laboratories have, in the last 2 years, been using the MacMichael viscosimeter for determining the consistencies of all kinds of greases. We are, unfortunately, not able to ask the opinion of the inventor of the instrument as to such use, as Mr. MacMichael was drowned in 1921, but I have been assured by the makers[2] of the machine that it is intended for liquids only and not for plastic solids. In their opinion it should not be used for greases except at temperatures above their melting-points. Yet numerous specifications contain what purport to be MacMichael limits for cup greases at 70 or 80 deg. fahr. As a matter of fact, they are nothing of the kind.

In the MacMichael instrument the degrees of torsion are proportional to the depth of immersion of the cylindrical bob in the substance under test. Consequently the depth of immersion must be known and stated, or else the MacMichael degrees must be based on unit immersion, by dividing the torsional degrees by the depth of immersion of the bob expressed in centimeters. Usual procedure, on the contrary, is to fill the sampling cup to the top, determine the torsion and call this figure MacMichael degrees. The instrument is so constructed that the top of the sampling cup is not a definitely fixed point relative to the bob. When the cup is filled level full with grease, the immersion of the bob is approximately 4 cm. (1.57 in.). Consequently, most MacMichael viscosities that appear in specifications are about four times too great; that is, a standard commonly expressed as 80 to 100 deg. MacMichael usually means about 20 to 25 deg. The confusion arising from this mistaken idea of what constitutes the primary unit is serious and results in the unwarranted rejection of products which have been honestly "made to order."

[2] Elmer & Amend, New York City.

As most greases are not liquids but are plastic solids, there are valid theoretical objections to using an instrument designed for liquids. The laws of the movement of plastics and of liquids under shear are entirely different. Moreover, all greases suffer a loss in consistency under continued working, and, in the MacMichael viscosimeter, cup greases especially behave in a way which makes it impossible to obtain constant reading. As the sample of grease rotates in contact with the bob, its consistency is changing. In addition, the bob gradually forms a vortex in the grease that results in a lowering of the upper point of immersion. The dial readings, after a large initial throw, drop rather rapidly, and continue to drop as the bob works itself free of the grease. At the end, it is impossible to determine accurately the depth of immersion, and the grease has suffered a loss in body which depends on the time the rotation has continued. The crude expedient, practised in certain laboratories, of pushing the grease against the bob with a spatula in an effort to maintain the original level, is certainly not permissible in any work which deserves the name of scientific.

It is scarcely profitable to multiply examples of the evils into which specification writers are falling. The evidence already presented makes it clear that consumers are standing in their own light by broadcasting specifications based on limited experience and insufficient knowledge of their own lubrication problems and of petroleum lubricants in general. When a lubricants manufacturer receives a vague set of standards in which specific gravities are stated but not the temperatures at which they are to be taken; in which the maximum evaporation loss is given but not the temperature or duration of heating, nor the size of the sample; in which the percentage of tarry matter is fixed but not the method for determining it, the conscientious manufacturer can do nothing but return the specifications with a request for more complete information. The prospective customer may be annoyed by the delay but he has only himself to blame for it. The manufacturer cannot run the risk of having goods rejected, through assuming that the customer's wishes are understood. Let us hope that the two principles elucidated; that is, pertinence and enforceability, combined with definiteness of statement, will be adopted as standard for all specifications.

PROBLEMS OF BRAKE ADJUSTMENT

(*Concluded from p.* 749)

fore installation in the chassis. The latter method seems preferable, one pertinent reason being that burnishing or burning-in is a high-speed operation. Brake adjustment is a slow-speed operation. Burning-in brake-lining on a completed car raises brake-drum and brake-lining temperatures unequally due to the lack of proper adjustment. If adjustment then follows as the next process before cooling, a possibility of error exists in adjustment due to unequal expansion of parts. Few production lines could permit a time interval to allow for proper cooling between these two operations.

The methods of brake adjustments suggested have been tried out in practice under varying conditions with gratifying results. The principle of scientific measurement of braking forces and the standards of practice developed therefrom have been heartily approved on production lines, in laboratories, in fleet-owners' garages and in brake service-stations. Better results at less cost will result from the adoption of a scientific means for brake adjustment, which then no longer will be the troublesome and uncertain problem that it is today.

Credit is due H. H. Allen for showing mathematically the correlation between the readings obtained with our brake-testing machine and vehicle weight and deceleration while on leave of absence from the Bureau of Standards, City of Washington.

The Torque-Equalized Brake

By G. L. Smith[1]

Washington Section Paper — *Illustrated with* Charts and Drawings

ABSTRACT

Brake action extends from the foot-pedal through various connections and devices to the point of contact of the braked wheel on the ground but, although brake-development work has been extensive for that portion of the brake mechanism which extends from the foot-pedal up to the point of application of brake pressure, the author says that beyond this point practically no improvement has been made. He says further that a study of brakes and the retarding forces they exert on the road surface reveals the primary cause of brake troubles, and then analyzes the design of an efficient braking-system for automobiles, first outlining the ideally perfect mechanism without regard to mechanical limitations.

According to the author, pressure equalization of brakes does not produce equalization of the braking action on the road unless the brake friction and the tire friction are the same for all four wheels and that, to produce positive equalization of brake force, it must be accomplished through the brake anchorages, because the forces which they resist are always proportional to the force exerted by the tires on the road. To balance this wheel-pull on the road, the right and the left brake-anchorages must be interconnected so that one brake-force reacts against the other because, in this way, any unbalanced force will produce movement and this movement can be utilized to decrease the pressure of the stronger brake while increasing that of the weaker one until the unbalanced force is eliminated and the movement stops.

Means of accomplishing torque equalization are then illustrated and described, and the results of tests of torque-equalizing mechanisms of various designs are presented, together with accompanying charts. In conclusion, it is said that considerable study has been devoted in the last year to the subject of airplane brakes, and that a modified type of torque-equalized brake has been developed for use on heavier-than-air craft which gives positive control of brake power as well as brake equalization.

In analyzing the general trend of development work devoted in the last few years to the improvement of brakes for motor-vehicles, one cannot but be impressed with the fact that this work has been partial to one phase of brake action and has neglected the other phase. The whole subject of brake action extends from the foot-pedal through various connections and devices to the point of contact of the braked wheel on the ground. This development work has been extensive for that portion of the brake mechanism extending from the foot-pedal up to the point of application of brake pressure, but beyond that point practically no improvement has been made. Brake anchors for both internal and external brakes are the same in principle as they have been for many years, the brake being secured as rigidly as practicable to a fixed part of the axle and each anchorage being independent of the other, the result being that the right brake does not know what the left brake is doing. We hear much about hydraulic, pneumatic and mechanical brakes, booster brakes and servo brakes, but all these terms apply to the mechanism for actuating the brakes and not to the brakes themselves and these mechanisms do not remedy any inherent defects in the brakes. A study of brakes themselves and the retarding forces they exert on the road surface has revealed what is manifestly the primary cause of brake troubles.

Brake Action

Concerning the design of an efficient braking-system for automobiles, let us first outline the ideally perfect mechanism without regard to mechanical limitations. To start from the ground up, literally as well as figuratively, we have a mass of varying weight supported on four points of contact with the ground, these points forming a rectangle, with the center of gravity approximately above the center of the rectangle. The frictional holding-power of these four points of contact with the ground determines the limit of braking power obtainable and, to avoid any tendency toward rotary movement, the equivalent of the retarding forces at the four points of contact should pass approximately through the center of gravity.

When it is considered that the tire friction on the road is a variable quantity, as is also the brake friction on the drums, it is evident that the ideal mechanism must eliminate these variables from the equation if rotary movement is to be avoided, and that the right and the left forces must balance themselves. This balance must be maintained through variations in road friction due to characteristics of the road surface; through variations in tire pressure on this surface, since the retarding force is a product of pressure as well as friction; and through variations in brake friction, due to a variety of causes.

Thus far, the ideal mechanism partakes of the nature of a differential in its action, but we desire to avoid the shortcomings of such a mechanism so that total loss of braking power on one side will not involve a total loss on the other side. We prefer to use this other side up to the limit beyond which rotary movement, or skidding, would take place; in other words, we desire to utilize the lever action of the front and the rear wheels on a side to hold the car in a straight line without producing any appreciable side-slip of these wheels, and in this way obtain the maximum possible retardation without producing rotation.

We desire to utilize as much of the car weight on all wheels as possible without losing steering control; that is, we wish to take advantage of the action of centrifugal force in transferring more than one-half the weight to the outer wheels when turning a corner, thus reducing the danger of locking an outer wheel, and to utilize the transfer of weight to the front wheels in retarding forward movement, thereby reducing the danger of locking a front wheel before the rear wheels lock. This can be done with safety only if the equalization of the brake force is substantially accurate. We also wish to design

[1] M.S.A.E.—Engineer, United States Ordnance Co., City of Washington.

the ideal mechanism so that the front brakes will not increase the compressive stresses on the steering tie-rod or react in any way on the steering-mechanism.

In the connections from pedal to brake the ideal mechanism should utilize the twisting action of the axles to assist the operator in applying the brakes and thus reduce the pedal movement needed to apply them, but without producing a self-locking action of the brakes or vibration of the foot-pedal. Brake-levers themselves should be of the unlocking type to produce smooth taking-hold of brakes, the maximum possible forward wrap of brake-bands should be used to reduce pedal pressure for braking forward motion, and the self-locking action of the brakes in reverse motion should be utilized to make up for loss of power due to the small amount of reverse wrap of the brake-bands.

Combined with the foregoing features should be included the minor yet important essentials of simplicity and reliability; uniformly powerful action yet smooth in its retardation of the car; self-adjusting action with the minimum of servicing, freedom from sudden and widely variable stresses on the axles, springs and other parts of the chassis; cheapness of cost; and ease of manufacture.

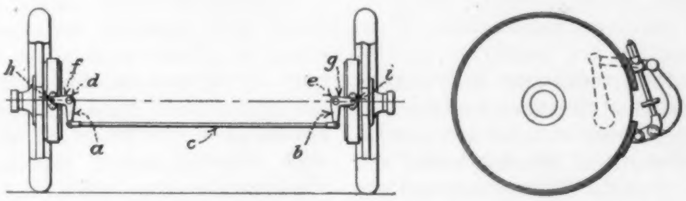


FIG. 1—METHOD OF BALANCING BRAKE-FORCES

A System of Bell-Cranks *a* and *b* and a Cross-Rod *c* Connecting Them Is Shown at the Left. The Main Bell-Crank Pivots *d* and *e* Are Carried by the Axle, the Horizontal Arms *f* and *g* of the Bell-Cranks Are Pivoted to the Brake-Bands at *h* and *i*, and the Vertical Arms *a* and *b* Are Connected to the Cross-Rod *c*. With This Arrangement the Brake-Bands Will Rotate in Opposite Directions If Any Unbalanced Force Exists. The Brake-Band Pulling the Harder Will Rotate With Its Drum, and the Other Brake-Band Will Rotate in the Reverse Direction. This Brake-Band Rotation Is Then Utilized To Vary the Brake Pressure. The Action of the Torque-Equalizing Method Is Shown at the Right. With Positive Connections between Brake-Levers and Foot-Pedal, That Is, with No Pressure Equalizer Fitted, the Thrust Links Forcing the Heads of the Brake-Levers Forward Will Swing Up on One Side and Down on the Other, If Properly Positioned So That the Thrust Is Off the Axle Center and in the Direction of Rotation of Forward Movement of the Wheels, Thus Forcing the Lever Head Away From and In Toward the Axle Center, Respectively, As Shown. Therefore, It Is Evident That Rotation of the Brake-Band with the Brake-Drum Reduces the Brake-Band Pressure, and That Rotation of the Brake-Band Against Its Brake-Drum Increases the Brake-Band Pressure. Consequently, the Two Brake-Forces To Be Equalized Are Employed As the Actuating Means for Producing Equalization, and All Variables Such As Brake and Tire Friction and Tire Pressure on the Road Are Integrated Out of the Equation

TORQUE EQUALIZATION

It will be conceded that pressure equalization of brakes, the prevailing method now in use, does not produce equalization of the braking action on the road unless the brake friction and tire friction are the same for all four wheels. To produce positive equalization of brake force it must be accomplished through the brake anchorages, as the forces which they resist are always proportional to the force exerted by the tires on the road. To balance this wheel-pull on the road, the right and the left brake-anchorages must be interconnected so that one brake-force reacts against the other because, in this way, any unbalanced force will produce movement and this movement can be utilized to decrease the pressure of the stronger brake while increasing that of the weaker one until the unbalanced force is eliminated and the movement stops. A variety of methods can be used to accomplish this result but the simplest appears to be that shown at the left in Fig. 1, which is a system of bell-cranks *a* and *b* and a cross-rod, *c*, connecting them, the main bell-crank pivots *d* and *e* being carried by the axle, the horizontal arms *f* and *g* of these bell-cranks pivoted to the brake-bands at *h* and *i* and the vertical arms *a* and *b* connected to the cross-rod *c*. With this arrangement the brake-bands will rotate in opposite directions if any unbalanced force exists; the brake-band pulling the harder will rotate with its drum and the other brake-band will rotate in the reverse direction.

This brake-band rotation is then utilized to vary the brake pressure. With positive connections between brake-levers and foot-pedal, that is, with no pressure-equalizer fitted, the thrust links forcing the heads of the brake-levers forward will swing up on one side and down on the other, if properly positioned so that the thrust is off the axle center and in the direction of rotation of forward movement of the wheels, thus forcing the lever head away from and in toward the axle center, respectively, as shown at the right in Fig. 1. Therefore, it is evident that rotation of the brake-band with the brake-drum reduces the brake-band pressure, and that rotation of the brake-band against its brake-drum increases the brake-band pressure. Consequently, the two brake-forces to be equalized are employed as the actuating means for producing equalization and all variables such as brake and tire friction and tire pressure on the road are integrated out of the equation.

The rotary movements of the brake-bands must necessarily be limited and, while it is advisable to provide limit-stops as a safety feature, this equalizing movement is automatically limited by the action of the brakes. In the case of one wheel being on slippery pavement, the effective brake-force cannot be increased beyond that produced by the tire on the road and, when this limit is reached, the wheel locks and the pull of the other brake then acts to compress the brake more tightly against the drum on the locked wheel. Since the brake-lining has very little elasticity, the movement of the cross-rod toward the rolling wheel is soon stopped and further loss of brake power on that side is arrested.

As previously stated, rotation of the brake-bands is utilized to vary the brake pressure, forward rotation reducing and backward rotation increasing the brake pressure, so that equalization of brake forces will be obtained for braking forward movement; but it is manifest that, for rearward movement, rotation of the brake-band with the brake-drum will increase the pressure and cause the brake exerting the greatest force to exert a still greater force so that all the work is thrown on one side or the other. This action, however, is avoided by cutting out the equalizing action in backing, the brakes being anchored by fixed anchorages which constitute the limit-stops in one direction of rotation.

To make contact with the foregoing limit-stops a limited free rotation of the brake-bands takes place and, as this rotation is in the direction to increase the brake-band pressure, the brakes become self-locking to a limited extent. To counteract this locking action, the pull-rods are pivoted at points below the center of twist of the rear axle and above that of the front axle, so that an unlocking effect is produced to counteract the self-locking action of the brake-bands. This unlocking tendency is intentionally too small to counteract entirely the self-locking brake-action, as it is desired to get powerful brakes in backing with small reverse wrap of the brake-bands. This combination improves the brake action for

forward movement also, since the pull-rods *assist* the brake-lever action and, together with the forward wrap, produce more powerful braking effect with less pedal-travel. The increased forward wrap is obtained without sacrifice of equalization, as the equalizing movement is sufficient to handle a 2 to 1 variation in the friction ratio between the two sides. This has been found by tests to be sufficient, although a ratio as high as 3 to 1 can be equalized if desired.

Connections between brake-pedal and brake-levers are simplified by the elimination of the pressure equalizer, but it must be borne in mind that the rotary action of brake-bands in producing torque equalization distributes the foot-pedal pressure to the two sides in a varying proportion, so that one pull-rod may be in greater or less tension than the other, depending upon the amount and direction of rotation. This necessitates connections to the two sides of equal, or of approximately equal, stiffness. Should the pull be direct on the left side and through a long shaft of insufficient torsional strength on the right side, the latter side would give to any increased pull and detract from the equalizing action. This is not injurious to the equalization for moderate brake-application but, for sudden stops requiring full brake-power, it will cause the car to slue the rear end to the right. The equalizing movement does not catch-up with the releasing action, due to twisting of the shaft, and an unbalanced brake-action is the result. This sluing action has occurred only on those cars having torsional shafting that is considerably out-of-balance and, in every case, has been eliminated either by the use of larger shafting or by more nearly equalizing the length of shafting in torsion between the two sides.

Torque-Equalizing Tests

Tests of torque-equalizing mechanisms of various designs, covering many thousands of miles, have been made, and some remarkable results have been obtained. In most cases, cars so equipped maintain a straight course regardless of whether one or both rear wheels are locked, even though the driver's hands are removed from the steering-wheel; but, on two-wheel-brake cars, an easy sluing action to right and left has been experienced a few times, showing a slight "hunting" action. In one public demonstration this action took place with the steering-wheel free; the speed at the start 30 m.p.h., the street was wet, and observers reported that one wheel was locked and the other was not. The car slued about 5 deg. to the right, checked itself and slued a less amount to the left, then straightened-out and came to a stop. This demonstration proved that the brakes were exerting an actual steering action on the car.

This steering action on the part of the brakes was discovered early in the tests of torque-equalized mechanisms, but it was some time before a satisfactory explanation of this action could be determined. The first clue leading toward a solution was noted in observing the action of the cross-rod at the moment a wheel locked; its movement was invariably toward the rolling wheel, thus showing a drop in the retarding force of the locked wheel. The second clue was the action of the cross-rod in braking on a curve, the movement being a slight one toward the outer wheel. This brought to our attention the fact that the outer wheel, in a skid as well as on a curve, carries more than one-half the weight of the car due to the centrifugal force generated. The sequence of events is then as follows:

Suppose a skid to the right. First, the right wheel locks and loses its retarding power, which causes the car to skid to the right. Centrifugal force then increases the pressure of the right tire on the road, which causes the right wheel to start rolling again and thereby increases its retarding power so that it is more than that of the left wheel, which is carrying less than its share of car weight. As a result, the skid is checked; then the car straightens-out, overdoes it, and slues to the left. If the left skid is at all pronounced, a similar action then takes place to slue the car back to the right again. This action shows that torque equalization produces a substantially accurate balance between the two brakes; otherwise, the outer wheel, when it starts rolling again, might not build up sufficient power to overbalance the inner or pivot wheel. This sluing action has not yet been experienced with four-wheel-brake cars, as the movement has always been straight ahead except in cases in which the brakes are applied on a well-crowned road; under such a condition, a slight tendency to slide toward the lower side in case the rear wheels lock is sometimes noticeable.

Stresses on axles are appreciably reduced, since one brake acts against its opposite brake. With ordinary types of brake anchorage, the full power of one brake may be thrown on one axle-end while at the same time the other side may not be holding at all, due to the bouncing of the wheel off of a rough road. In such case, with interconnected anchorages, this power would be slackened as the brake that is doing all the work would pull the cross-rod over, thus slackening the brake-band pressure.

Actual records of cross-rod movement made on a recording instrument show this throw of the cross-rod to be very rapid and extensive under rough-road conditions. On the first car equipped with the torque equalizer, the car was driven about 35,000 miles before the installation of the mechanism; during that time, four rear-springs were broken, two right and two left ones. Since the equalizer was installed, no springs have been broken and the car has covered about 60,000 miles to date. Later, torque-equalized front-brakes were fitted to this car, using the old axle and springs. Tests of braking power made on a recording instrument showed that stops from a 20-m.p.h. rate of speed could easily be obtained within 16 to 20 ft.

Front and rear brakes, torque equalized, have also been applied to a few Ford cars, without any stiffening of chassis parts or axles. A test of one of these, a Ford coupe, gave the results shown in Table 1.

TABLE 1—TORQUE-EQUALIZED BRAKES ON A FORD COUPE

Installation of Brakes on	Speed, M.P.H.	Average Stopping Distance, Ft.
Front and Rear	20	14.5
Front Only	20	27.5
Rear Only	20	27.5 to 36.5
Front and Rear[2]	20	16.0

[2] With steering tie-rod disconnected.

The last test in Table 1 was made to prove that front brakes did not load-up the steering-gear. In this test, the left front-wheel maintained its alignment, the left brake pulling against the right brake through the cross-rod. In applying the brakes when backing, however, the steering tie-rod does carry the load but is placed in tension by it and is amply strong for such stress. Tests during the winter with the Ford coupe were made on slippery streets, and it was found impossible to throw the car intentionally into a serious skid. Occasionally a limited amount of angular change of direction could be

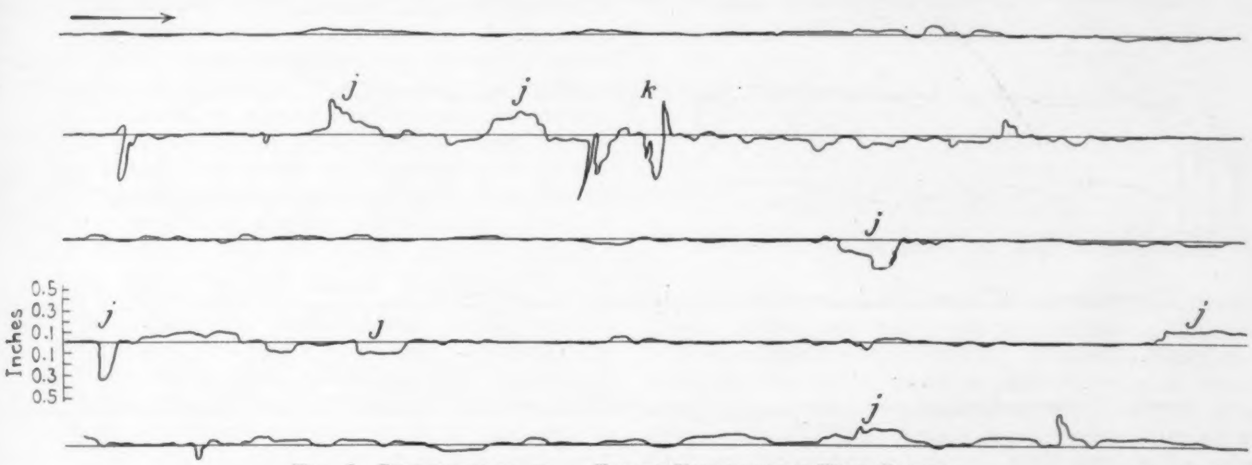


Fig. 2—Reproduction of a Torque-Equalization-Test Record
The Record Was Made on City Streets That Generally Were Good But Which Had Occasional Rough Spots and Hard Patches of Snow and Ice; But the Major Portion of the Road Surface Was Dry and Fairly Clean. Points Marked *j* Indicate That One Wheel Was on Wet or Slippery Pavement. The Point Marked *k* Indicates a Spot both Wet and Rough Which Caused Considerable Pounding of the Rear Axle and Consequently Great Variations in Tire Pressure As Well As Some Change in Pedal-Pull Due to Considerable Body Movement on the Rear Springs. Where the Road Surface Was Good and Uniform, Very Little Cross-Rod Movement Is Shown and the Curve Follows the Central Line Fairly Accurately

obtained, but this movement was checked and the car slid bodily, sidewise, to a certain extent. The maximum angle of slue obtained was estimated to be about 20 to 30 deg. During these tests it was found that the car was stopped most quickly on ice by throwing the steering-wheel hard over and locking all four wheels, and that no skidding would occur if the road surface was approximately level.

Recognizing the fact that many engineers, although admitting the mechanical accuracy of the torque-equalized method, are of the opinion that pressure equalization is sufficiently accurate for all purposes, extensive tests have been made to determine just how much work the torque-equalizing mechanism is called upon to do. To this end a recording machine was connected to the rear cross-rod. A paper ribbon traversing at a slow rate of about 10 in. per min. was driven by an electric motor started by the brake-pedal. A 1-in. depression of the brake-pedal would close the circuit. A pencil carried by a swinging arm was traversed laterally across the ribbon by the cross-rod, this movement being obtained by means of a piano wire run through a copper tube. Tests showed the machine to be very accurate and without any lag. Many yards of record were obtained in this way; some of the record is shown herewith.

Fig. 2 is a reproduction of a record that was taken on city streets that generally were good but which had occasional rough spots and hard patches of snow and ice; but the major portion of the road surface was dry and fairly clean. Points marked *j* indicate that one wheel was on wet or slippery pavement. The point marked *k* indicates a spot both rough and wet which caused considerable pounding of the rear axle and consequently great variations in tire pressure as well as some change in pedal-pull due to considerable body movement on the rear springs. Where the road surface was good and uniform, very little cross-rod movement is shown and the curve follows the central line fairly accurately.

Fig. 3 shows a similar curve recorded on good concrete and macadam country roads that were mostly dry but

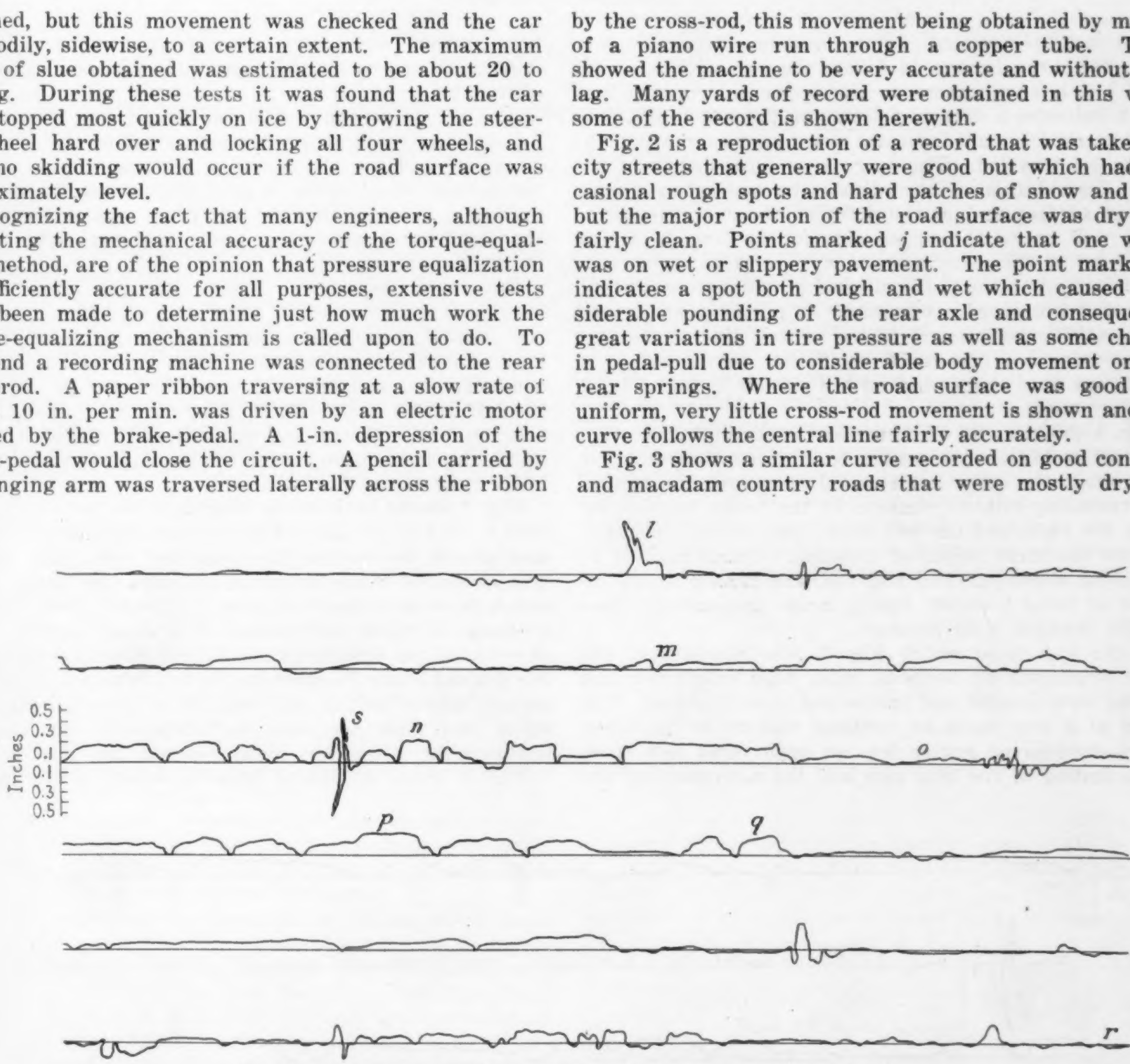


Fig. 3—Test Record for Good Concrete and Macadam Country Roads
The Roads Were Mostly Dry But Had Occasional Wet Spots. The Curve Follows the Central Line at the Start But Later Creeps to the Upper Side of the Line, Which Indicates a Drop in Friction on the Left Brake. The Point Marked *l* Indicates a Wet Spot over Which the Left Wheel Traveled

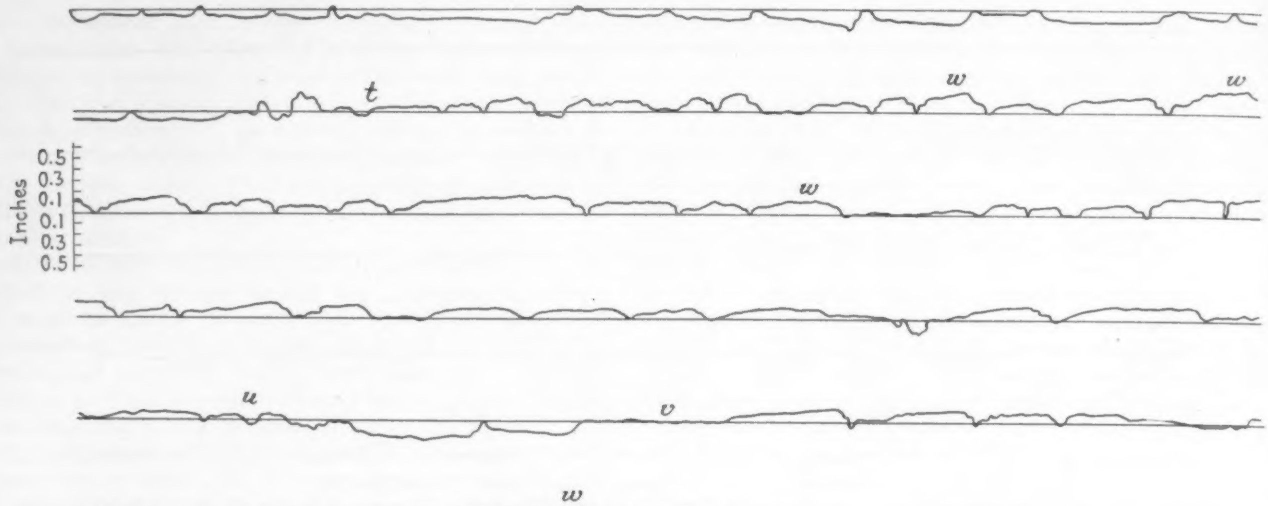


FIG. 4—TEST RECORD OVER EXCELLENT ROADS

All Conditions Were Favorable to Uniform Brake-Action. The Curve Crosses and Re-Crosses the Central Line, Revealing Relative Changes in the Brake Friction between the Right and the Left Sides. The Letters *t*, *u* and *v*, Indicate the Three Points of Crossing. Points Marked *w*, Indicating a Gradual Rise and Fall, Are Caused by an Increase of Pedal Pressure during Brake Application

had occasional wet spots due to melting patches of snow. Here the curve is seen to follow the central line at the start but later it creeps to the upper side of the line, which indicates a drop in friction on the left brake. The point marked *l* again indicates a wet spot over which the left wheel traveled. The increasing irregularity of the curve beyond this point indicates increasing roughness of road surface and, at the point *m*, the curve begins to creep well up to the upper side of the line, becoming maximum at the point marked *n*, then working back to about central at the point marked *o*, which was a rough descent, increasing to maximum at points *p* and *q* and then working back again to the central line at the end of the run, *r*. The rapid oscillatory movement at *s*, which was on a steep winding hill similar to *k* in Fig. 2, is to be noted.

Fig. 4 shows a run over excellent roads in fine weather with all conditions favorable to uniform brake-action. Here again the curve crosses and re-crosses the central line, revealing relative changes in the brake friction between the right and the left sides; the letters *t*, *u* and *v*, indicate the three points of crossing. Points marked *w*, indicating a gradual rise and fall, are caused by an increase of pedal pressure during brake application, since friction changes with pressure.

In the run from which Fig. 5 was reproduced, the worst conditions of wetness, mud, road roughness and the like were sought and the record is self-evident. The record at *x* was made by turning sharply to the right over a stone-paved gutter into an unsurfaced new road. The pounding of the rear axle and the movement on the rear springs were very pronounced and the cross-rod movement was nearly the maximum movement allowed to either side.

The record reproduced at the top of Fig. 6 was made by applying the brakes when one wheel or the other was on hard snow or ice, together with occasional records where both wheels were on good dry pavement. Portions marked a_1 indicate that the left wheel was on ice, b_1 that the right wheel was on ice, and c_1 that both wheels were on dry pavement.

The lower record was made when the brake adjustment was varied one-half turn on a side at a time. At the point d_1 is indicated the correct adjustment that allows no cross-rod movement; points e_1, f_1 and g_1, indicate one-half, one, and one and one-half turns of set-up on the left brake, respectively; points h_1, i_1, j_1 and k_1, indicate one-half, one, one and one-half and two turns of set-up on the right brake, respectively, after setting the left brake back to the d_1 adjustment.

Fig. 7 shows brake-force diagrams for points e_1, g_1, h_1 and j_1, of Fig. 6, taken with a recording decelerometer, and should be studied in connection with that record. The height of these diagrams indicates the brake force, and it is evident that variation in this force resulting in a change in brake adjustment is of small amount. This shows that the equalizing mechanism automatically gives the desired brake pressure on the two brakes so that they become self-adjusting and require no personal attention other than that necessary to compensate for wear of brake-lining when the pedal reaches the floor-boards.

Fig. 8 gives a clearer idea of brake power versus

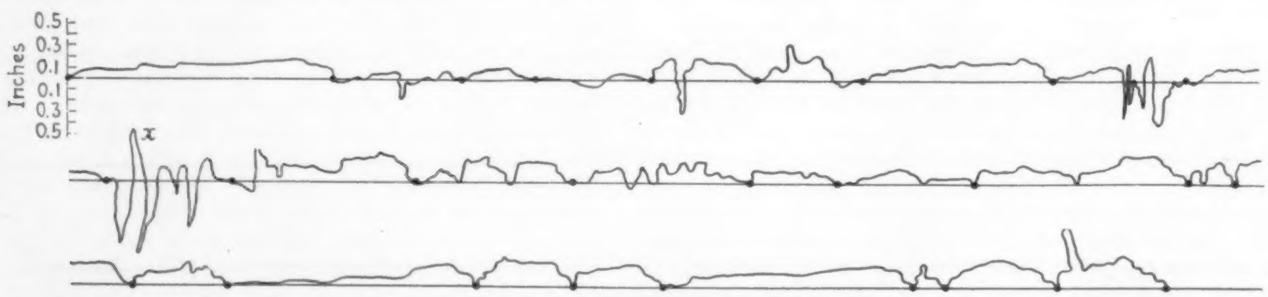


FIG. 5—TEST RECORD UNDER BAD ROAD-CONDITION

The Worst Conditions of Wetness, Mud, Road Roughness and the Like Were Sought. The Condition Indicated at *x* Was Caused by Turning Sharply to the Right over a Stone-Paved Gutter into an Unsurfaced New Road

brake adjustment. The upper dotted curve shows brake power for the records reproduced in Fig. 6 and the lower dotted curve shows corresponding cross-rod movements in tenths of an inch. The full-line curves show similar data obtained on a previous test of like nature. The straightening-out of the cross-rod-movement curves toward a horizontal line at the ends indicates an arresting of the equalizing action so that excessive loss of brake power is avoided in case one wheel is on a slippery surface like snow or ice.

Road Friction and Brake Friction

Without going into the mathematical details of the subject, it may be of interest to note that the maximum brake-power loss due to the equalizing action is about 15 per cent and that the power loss due to a plus or minus error in brake adjustment either side up to one turn is negligible. The significance of the cross-rod-movement curves is also mathematically demonstrable by a comparison between right or left friction characteristics.

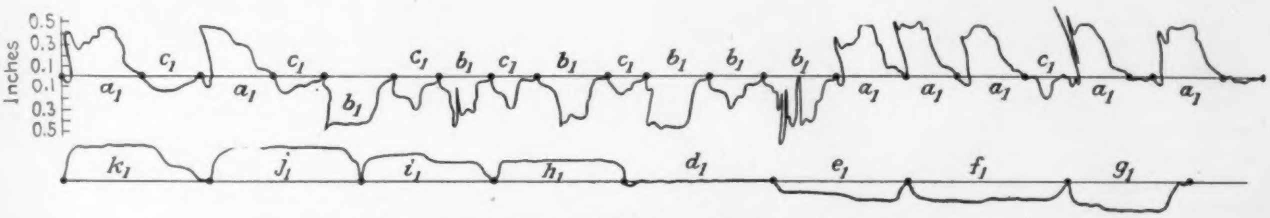


Fig. 6—Test Records Made Under Special Conditions
The Record at the Top Was Made by Applying the Brakes When One Wheel or the Other Was on Hard Snow or Ice, Together with Occasional Records Where Both Wheels Were on Good Dry Pavement. The Lower Record Was Made When the Brake Adjustment Was Varied One-Half Turn on a Side at a Time

While it is impossible to discriminate between the road friction and brake friction, since each has its effect on the cross-rod movement, it is possible by assuming one of them a constant to find the ratio between the right and the left values of the other. The result in figures is as follows:

For a 0.1-in. cross-rod movement to the right, we have
Friction to the Right $\div$ Friction to the Left $= 1.3/1.0$ (1)
For a 0.1-in. cross-rod movement to the left, we have
Friction to the Left $\div$ Friction to the Right $= 1.3/1.0$ (2)

For greater cross-rod movement add 0.3 to the numerator for each extra 0.1 in. of cross-rod movement. From this it is evident that a 0.3-in. cross-rod movement gives a ratio of 1.9 to 1.0. Scales having divisions of 0.1 in. are shown on the records reproduced in Figs. 2 to 6 inclusive, and from them it is possible to measure the friction ratio being overcome at any point on the curves.

To explain more clearly, consider the point p in Fig. 3. This point scales about 0.25 in. above the central line, indicating a friction ratio of 1.75 to 1; but, due to the action of the torque-equalizing mechanism, the brake pressure is divided between the two brakes so that the force at the road surface is the same, or practically the same, on each side. Whereas, were the brakes in this case applied by the use of a pressure equalizer, or yoke, this force would be 1.75 times greater on one side than on the other and could not be eliminated.

From the general character of the curves shown herewith, it is evident that the equalizing action is going on almost constantly during the time that the brakes are applied. Even under the most favorable conditions, such as those shown in Fig. 4, the extent of the movement at several points indicates extensive and dangerous differences between the right and the left retarding forces acting on the road surface, which, with a pressure equalizer, would not be eliminated. It is easy to imagine

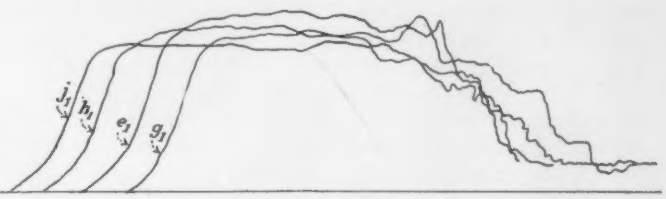


Fig. 7—Brake-Force Diagrams for the Points of Fig. 6
The Data Were Obtained with a Recording Decelerometer and Should Be Studied in Connection with the Records of Fig. 6

a combination of circumstances together with these temporary differences which would produce skidding or an otherwise dangerous situation. A careful study of many such records taken under a large variety of conditions shows conclusively an almost continuous and often erratic change in the friction characteristics which govern the two forces applied to the road surface in retarding the speed of the car. For moderate brake-pressures producing a negligible slipping between the tire and the road, the curves are much more regular but creep slowly back and forth across the central line. This shows that such variations as explained for Fig. 4 are due to a gradual change in the friction of the brake-lining itself. This friction may increase on one side at the same time that it is decreasing on the other side; or, if both sides show increasing or decreasing friction at the same time, then rates of increase or decrease are different. Moisture and heat tend to increase the rate and amount of this change in brake-lining friction as well as pressure and speed, with the inevitable result that no two cases of brake application are governed by exactly the same conditions so far as the brakes themselves are concerned.

Many engineers claim that such changes in brake-

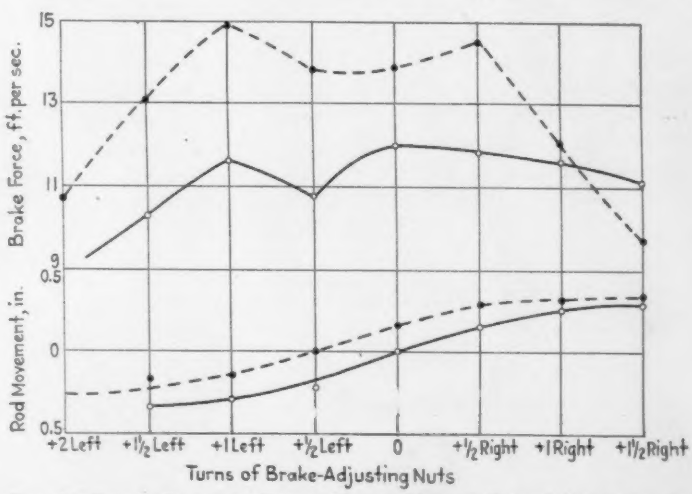


Fig. 8—Chart Showing Brake Power Versus Brake Adjustment
The Upper Dotted Curve Shows Brake Power for the Records of Fig. 6. The Lower Dotted Curve Shows Corresponding Cross-Rod Movements in Tenths of an Inch. The Full-Line Curves Show Similar Data Obtained on a Previous Test of Like Nature

lining friction are not great where the lining is protected from dirt, grease and moisture, and for this reason the internal enclosed-shoe brake is looked upon with favor. Yet laboratory tests of brake-lining generally show an extensive change in friction due to the natural wear of the lining. It gradually smoothes down and a glaze is formed due to the polishing action of the drum. After a time this glazed surface pulls off and a new layer of lining comes into play. As the glaze forms, the friction drops and, as it wears off, the friction rises; so it is evident that unless this action is going on at the same time on each brake, a condition which would manifestly exist only by accident, then there must be relative changes in the brake friction on the two sides and consequent relative changes in the brake power. As shown in Fig. 4, in which the central line was crossed three times on one continuous run of about 200 miles, it would have been necessary to stop and adjust brakes three times to eliminate the effect of this frictional change on brakes having no equalizer, and on those provided with pressure equalizers this effect could not be eliminated.

But more important than the brake friction is the tire friction on the road, and this is a factor that cannot be controlled in any other way than by the principle of torque equalization. The holding power of the tire on the road is the ultimate key to the situation and controls the retardation of the car regardless of the type, power or efficiency of the brake system. Only by utilizing this tire friction to produce the equalizing action can the two forces delivered to the road surface be equalized. The principles of torque equalization operate directly to balance two forces, rather than indirectly by balancing the pressure which produces these forces and leaving the friction uncontrolled and free to upset this balance. It is thus seen that the torque equalizer accomplishes a result never before obtained in any type of wheel brakes by eliminating unbalanced action resulting from variation of the tire friction on the road.

Airplane Brakes

Considerable study has been devoted in the last year to the subject of airplane brakes and, as a result, a modified type of torque-equalized brake has been developed which gives positive control of brake power as well as brake equalization. The Bureau of Aeronautics of the Navy is now constructing a mechanism for test. A detailed description of this mechanism would be premature, as it is not yet completed; but its principles of operation are somewhat as follows:

The retarding force exerted by the two braked-wheels is directly proportional to the force exerted by the pilot in applying his brakes, regardless of the brake or tire friction. Consequently, he can use the maximum brake-power just short of causing the airplane to nose over, without danger of overdoing it. Movement of the rudder bar of the airplane upsets the equalization of the two brakes; it increases one brake-force and reduces the other one in the same proportion, so that the airplane can be steered by the brakes after making a landing. This steering action is also positive and unaffected by variations in the brake and the tire friction and can be accomplished in two ways, either by resisting the action of the equalizing mechanism by an applied force, or by varying the leverage of the equalizing mechanism. The latter method is believed to be the most reliable one, but both will be tried. The principal advantage of this arrangement for airplanes is the greater safety obtained by the invariable action of the mechanism, regardless of weather or ground conditions, so that the pilot always knows just what to expect from his brakes.

An Internal-Geared Four-Speed Transmission

By S. O. White[1]

Semi-Annual Meeting Paper *Illustrated with* Photographs and Charts

ABSTRACT

INTENSIVE study of vibrations has had to be made by transmission manufacturers who were seeking a means of obviating the car noise that has become known as "high-speed rattle" and which makes itself heard through the transmission case, although it is caused mainly by periodic vibrations in the engine and propeller-shaft. Out of this study has come a revival of the idea of using a "fast" rear axle, that is, one having a low ratio between the engine and driving axle, whereby the rotative speeds of the crankshaft and propeller-shaft can be reduced greatly and the vibrations at a given road-speed consequently diminished.

To make the fast axle, or low rear-axle ratio, usable satisfactorily with present cars the four-speed transmission has been developed to provide more reduction in the transmission without making the steps in ratio between the several speeds too large. Four-speed transmissions have not been satisfactory in the past because of the noise caused by spur-gears and the wear of the teeth. Recent developments in internal gearing have shown that it is entirely feasible to design a transmission having internal gearing for third-speed that is both reasonably quiet and highly efficient. Such a design is illustrated and described in detail by the author, who explains its operation.

It is important to arrive at a rear-axle ratio that is the best compromise for all operating conditions. This should be as "fast" as possible yet avoid the necessity of much more gear-shifting than the public is accustomed to at present. A fairly close approximation of the best ratio to use, as made by plotting engine revolutions per minute against car miles per hour for a given size of tire and with a variety of ratios, shows that most cars produced today do not operate at the most advantageous torque of the engine horsepower-curve and that engines are run at too high speed. This causes excessive periodic vibrations, noise, wear of the engine and unnecessary fuel and oil consumption. The relation of various axle ratios to engine horsepower and torque, in third and fourth-speeds, for two cars of different size, are shown in charts and discussed.

HIGH-SPEED rattle has been an annoyance to transmission manufacturers for many years in spite of their endeavors to overcome it. Although the transmission is only partly to blame for this, it happens to be the sounding-box or amplifier from which the objectionable disturbance reaches the ear of the passenger in the automobile. The noise is the result of a periodic vibration originated usually either by the engine or the propeller-shaft when operating the car at road speeds of 40 m.p.h. and more. The transmission manufacturer went as far as was found to be practical in the way of tightening bearings, bushings, sliding-gear fits, and the fit of all moving parts in the transmission that could be a possible source of rattle from outside vibration. It must be recognized that all of these moving parts must have some clearance if they are to function easily and smoothly, and must also retain an oil film between the working surfaces.

While this tightening process improved the situation, the high-speed rattle persisted, and in self-defense it has been necessary repeatedly to make a demonstration with a transmission fitted with a solid drive-shaft running through it, having no gears whatever in the transmission and with the clutch plate fitted at the forward end of the shaft with no backlash; in short, a direct rigid shaft-drive from the engine to the rear axle. Even under these conditions the noise was still present.

The story of engine balancing, vibration dampeners, flexible-clutch drives, and the like, is a familiar one. All of these helped to relieve the situation to the extent of pushing the vibration period to a little higher speedometer-reading, but usually some vibration was still evident, and, even if it was not made manifest as the familiar high-speed rattle, there were engine noise, roughness, and periodic-vibration effects that were disturbing to the passenger and detrimental to the life and general efficiency of the vehicle.

The obvious solution seemed to be to run the engine slower, but, as car performance could not be sacrificed, and this is controlled largely by the gear reductions between the engine and the road, the problem was passed back again to the transmission manufacturer. The first suggestion was to revive the over-speed transmission which was tried out years ago but abandoned because of gear noise and wear. It was found, however, that a certain type of internal gearing possessed remarkable properties of silent operation and efficiency, and several different designs of over-speed transmissions in which internal gears were employed for the over-speed feature were worked out.

Why Internal Gears Are Quiet

It may be well to pause for a moment to consider the internal gear. Some of its properties were pointed out recently by P. M. Heldt[2], and its tooth action as compared with that of a pair of external spur-gears will be fairly evident from Fig. 1. In the type of internal gearing under consideration herein the number of teeth on the spur-pinion and on its mating internal gear does not differ greatly. In the gear pair shown the difference is five, as the spur-pinion has 28 teeth and the internal gear 33 teeth. These gears are of 10-12 pitch, 25-deg. pressure angle. By comparison, the pair of spur-gears at the right in Fig. 1, which form the front-end constant-mesh pair in the transmission, have a great difference in tooth action. It would almost seem, in the case of the internal pair, that two or three teeth are in contact at the same time, but an accurate large-scale layout of the

[1] M.S.A.E.—Chief engineer, Warner Gear Co., Muncie, Ind.

[2] See *Automotive Industries*, March 26, 1927, p. 470.

tooth outlines shows that theoretically only one pair of teeth is in contact. It is believed, however, that, due to the spring of the parts and the presence of the oil film, we do have practically the effect of more than one tooth in contact at a given time.

When a pair of these internal gears is rolled by hand and the action is observed, it will be noted that the pinion-teeth make a very gradual approach into the gear-teeth. This is probably one of the reasons for the greater silence of the internal gearing as compared with the pair of spur-gears, as the pitch circles of the internal gear and its pinion are internally tangent to each other and not very different in diameter, so that their relative angular velocities are very different. In the case of spur-gears, the pitch lines are externally tangent and the teeth approach each other at such velocities that undoubtedly the impact of making contact is much greater.

This type of internal gear possesses, in addition to running more quietly than spur-gears at all times, the valuable quality of becoming quieter as the load on it is increased, in contrast with the spur-gear, which "howls" louder as the hill ascended is steeper or as the load carried is heavier.

Wear on the internal gears seems to be practically negligible, probably owing to the smooth tooth-action, the low velocity of impact, the distribution of the load and the better oiling-conditions, although we are using oil-hardening steel and drawing the gears to a scleroscope hardness of about 72.

Objections to Over-Speed Internal Gear

Because of these advantages of internal gearing that has a small tooth-difference, various designers have been working for some time on the problem of applying this gearing to an automobile transmission. The earlier designs were mostly along the lines of step-up gearing built upon a somewhat conventional transmission and used to provide an over-speed. This construction worked well and demonstrated that the general idea was practical and that reasonably quiet gears of this type could be made in regular quantity production.

Our first efforts also were along the line of an over-speed transmission, although we built the internal-gear mechanism directly into the gearbox as an integral design. It soon became evident that, while the car with an over-speed transmission performed much better than a standard car, nearly everyone who drove it wanted to drive in top speed practically all of the time and to use third speed only for acceleration and hill climbing.

The fundamental purpose of this whole program, it should be remembered, is to reduce vibration. The over-speed reduced the engine vibration by permitting the engine to run slower, but it did not decrease vibration or whip of the propeller-shaft, and propeller-shaft vibration can, and usually does, cause almost as much disturbance as engine vibration. Furthermore, with this construction the transmission was driving through gears nearly all the time, which seemed illogical. The internal gears run very smoothly and are remarkably efficient, but they are not perfectly silent and are not 100 per cent efficient. Furthermore, this internal gearing was rotating faster than engine speed, which presented both bearing and lubrication difficulties to solve.

Internal Gearing Reversed and Fast Axle Used

By turning the internal-gear mechanism end for end in the design and using a fast axle, we produced a four-speed transmission with direct drive on fourth-speed and an internal-geared third-speed. It was possible also, by varying the rear-axle ratio, to obtain a range of slower engine-speeds, and by slowing down the propeller-shaft speed by exactly the same amount that the engine speed was reduced, the whip of the propeller-shaft was eliminated. At the same time, it was discovered that the car ability, even with the fast axle, was such that 95 per cent of all driving was still done in top speed.

It is important that the reduction between the engine and the road wheels be in correct relation to car size and weight and to engine characteristics. This reduction will vary with different combinations of these factors. It is comparatively simple to try various axle-ratios until the desired performance is obtained, but with an over-speed type of transmission the amount of step between direct third-speed and over-geared fourth-speed becomes highly important, as it is not so simple to provide a variety of ratios in the internal-gear mechanism.

In considering the various possible ways of incorporating an internal-gear drive in an automobile transmission, we felt that it should be built as an integral part of the mechanism and that we should depart as little as possible from conventional design. Therefore, we have simply lengthened a three-speed transmission between the front-end constant-mesh pair of gears and the sliding gears and inserted the internal-gear train. This internal train, together with the shifting mechanism for picking up third and fourth-speeds, is shown in Fig. 2, in which *A* is the shank portion of a somewhat conventional main drive-gear for a unit-powerplant type of transmission mounting. The clutch is carried on the forward end of this shank, which is mounted in a bearing carried in the front wall of the transmission case as usual. The gear-head *B* is integral with the shank and drives a counter-shaft cluster in the conventional way. Piloted on the rear end of the main drive-gear portion *B* is the first spur gear *C* of the internal train. This meshes at the top of the internal gear *D*, which is integral with the hub *E*, mounted in a pair of roller-bearings which, in turn, are carried directly in the transmission case.

At the rear of the hub *E* is a spur-pinion *F*, that meshes at the bottom of the rear internal gear *G*, which is an integral portion of the transmission main-shaft *H*.

The axes of the main drive-gear and the main drive-shaft are in alignment but the internal-gear hub *E* is mounted eccentrically below the main axis of the transmission. On the splined portion of the main shaft *H* are the customary sliding gears for securing first and second-speeds, and a conventional sliding-idler arrangement provides the reverse.

Light Rotating Parts Make Shifting Easy

It was realized from the first that with a four-speed transmission more gear-shifting than is customary would be required, particularly between third and fourth-speeds. The experience of a great number of drivers has shown, however, that not nearly so much gear-shifting is necessary as was anticipated; first-speed is used for emergency purposes only, and second-speed is used as a rule only for starting from a standstill. However, we felt, and still believe, that it is essential that the shift between fourth and third-speeds be made smooth and easy to accomplish, with nothing like the effort and skill required to shift from third to second in a three-speed transmission; yet we believed that we should not go so far as to use what is known as a positive method of clutching, as this would allow a shift being made between fourth and third-speed without releasing the main

engine-clutch, which would of course impose severe strains on the rear system and consequent liability of breakage.

One of the first principles of easy gear-shifting is to provide light rotating-parts that offer the minimum of inertia to be overcome when changing from speed to speed, especially when shifting down from fourth to third-speed. Referring again to Fig. 2, the shift between third and fourth-speed is accomplished by means of the shaft *I*, which carries at its extreme forward end clutch gear-teeth *J*. These teeth are constantly in mesh with similar internal-teeth in the head of the main drive-gear *A*. The shaft *I* is shown in neutral position. A little to the rear of *J* is another set of clutch teeth *K*, of the same size, arranged to mesh internally with teeth in the first gear of the internal train *C*. When the clutch-shaft is moved forward, gear *C* is picked up on the clutch *K* and drives as a unit with the main drive-gear *A*. This combination provides the third-speed internal-geared drive.

To obtain the direct-drive fourth-speed, shaft *I* is shifted to the rear and the clutch teeth *L* at the rear end engage similar internal-teeth in the head end of the main shaft *H*, as shaft *I* is co-axial with the main shaft *H* and the main drive-gear *A*. The shifting shaft is moved back and forth by means of the ring *M*, carried in a wide channel at the middle portion of the shaft on three equally spaced studs *N*, which are moved longitudinally by a grooved collar *O* that slides on the outside of the eccentrically mounted internal-gear hub. This grooved collar is operated by a conventional shift-fork.

It will be evident from this construction that no heavy masses are involved in changing speed ratios, but that in dropping from fourth-speed back to third-speed the only rotating momentum that must be dissipated is that of the clutch-driven plate and the countershaft train, as in any conventional three-speed transmission, except that no reverse-idler weight is involved, as the reverse idler is out of mesh. The shift from fourth-speed back to third-speed can be made easily and surely at any fast road-speed whatever, although no reason for doing this should exist except in an emergency.

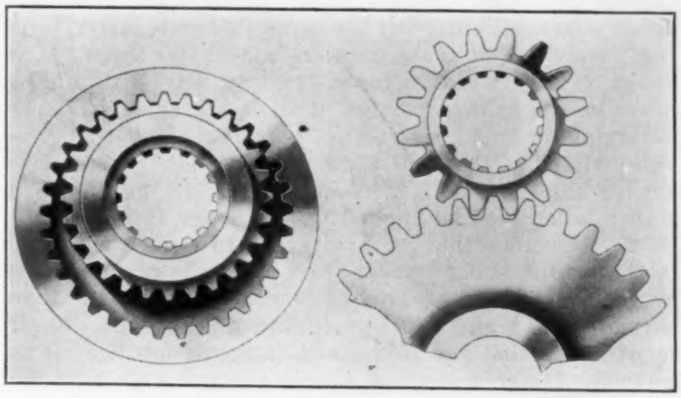


FIG. 1—COMPARISON OF INTERNAL AND SPUR-GEARS
The Pinion in the Internal Gear Shown in the Left View Has only Five Less Teeth than the Internal Gear, whereas a Great Difference Exists in the Numbers of Teeth in the Spur-Gears at the Right. Two or Three Teeth Seem To Be in Contact with the Internal-Gear Teeth at the Same Instant and, Owing to Spring of the Parts and to the Oil Film between Them, the Effect of More than One Tooth in Contact Probably Is Realized in Practice. Teeth in the Pinion Approach the Teeth in the Internal Gear Slowly and at a Very Small Angle as Compared with Spur-Gears, as the Pitch Circles of the Internal Gear and Its Pinion are Internally Tangent to Each Other and Not Very Different in Diameter, whereas the Pitch Circles of the Spur-Gears Are Externally Tangent and the Teeth Approach Each Other so Rapidly as to Make Relatively Much Greater Impact. As a Consequence of These Differences, the Internal-Gear Set Is Much Quieter, Becomes Still More Quiet as the Load on the Gears Is Increased, and the Wear on the Internal-Gear Teeth Is Almost Negligible

LOWER AXLE-RATIO REDUCES ENGINE SPEED

Fig. 3 is a perspective of the internal-gear train and shows a little more clearly, perhaps, its relation to the countershaft. The reference letters indicate respectively the same parts as in Fig. 2. The countershaft drive-gear *P*, at the front end of the transmission, is here in mesh with the main drive-gear *B*. The countershaft cluster has a rather long hub *Q*, which clears the space taken up by the internal-gear train, and immediately

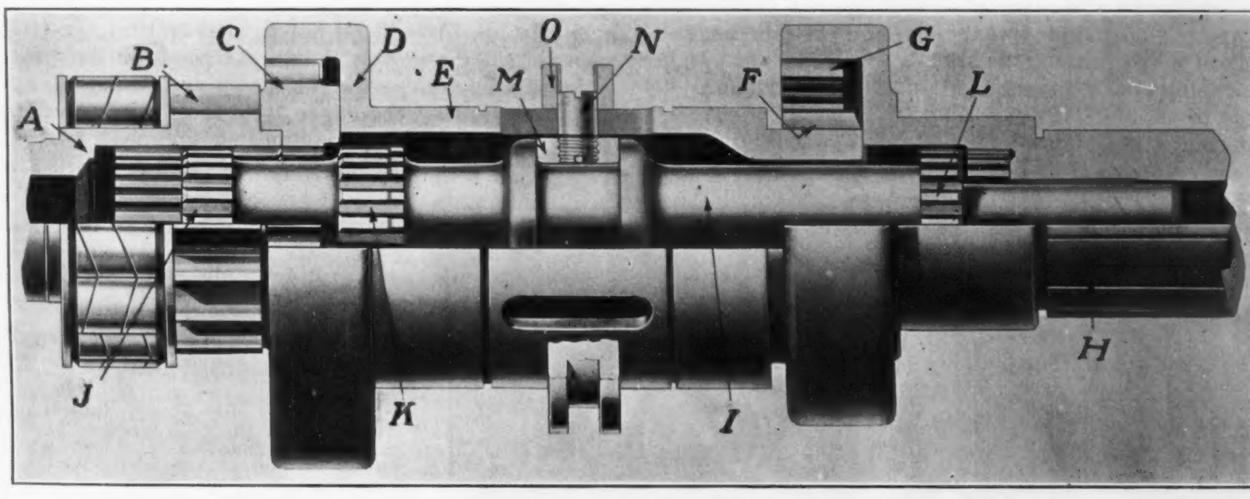


FIG. 2—INTERNAL-GEAR TRAIN AND SHIFTING MECHANISM FOR THIRD AND FOURTH-SPEEDS
At the Left Is the Shank *A* of the Clutch Shaft and at the Right Is the Splined Portion of the Main Shaft *H* of a Somewhat Conventional Sliding-Gear Transmission. The Latter Carries the Customary First and Second-Speed Gears. Gear-Head *B* Is Integral with *A* and Drives a Countershaft Cluster in the Conventional Way. Hub *E* of the Internal-Gear Train Is Mounted in a Pair of Roller-Bearings, Not Shown, and Has an Internal Gear *D* Integral with It at the Left and a Spur-Pinion *F* Integral with It at the Right. The Main Shaft *H* Carries Integral with It the Rear Internal *G*. The First Spur-Gear *C* Is Piloted on the End of Shank *A* and Engages Internal Gear *D* at the Top, whereas Pinion *F* Engages Internal Gear *G* at the Bottom, as the Axes of the Main Drive-Gear and Main Drive-Shaft Are Aligned but the Internal-Gear Hub *E* Is Mounted Eccentrically below the Main Axis of the Transmission. Within the Foregoing Assembly and Slidable Longitudinally by Three Studs *N* Is a Light Shaft *I* That Carries Integral with It the Clutch Gear *J* in Constant Mesh with Internal Teeth in the Head of Shank *A*; Clutch Gear *K* That Engages Pinion *C*; and, at the Right, Clutch Gear *L* That Engages Internal Teeth in the Main Shaft *H* to Give Direct Drive When Shaft *I* Is Moved Rearwardly. When This Shaft Is in Forward Position Third-Speed Is Provided through Internal Gears *D* and *G*. In Dropping from Fourth to Third-Speed, the Only Rotating Momentum to Be Overcome Is That of the Clutch-Driven Train *K* and the Counter-shaft Train, not Shown

behind this hub are the usual second-speed and low-speed gears, all cut from the same integral-cluster forging. Only one of these countershaft-cluster gears, *R*, is shown. They mesh in the customary way with sliding gears on the splined portion of the main shaft *H*.

Having in this construction a transmission that provides virtually the equivalent of two high speeds with a sure and easy shift between them, how may such a transmission best be applied? To answer this question, let us remember that we are trying to reduce vibration in the engine and propeller-shaft. This is accomplished by employing a rear-axle ratio considerably less than normal, thus reducing the engine and propeller-shaft speeds. All that the four-speed transmission does is to make the faster axle-speed convenient and usable by the average driver traveling in all parts of the Country, both level and mountainous. The advantages of the fast axle have long been well known, and car builders usually have employed as small a ratio of propeller-shaft axle as would give their cars satisfactory performance consistent with the popular demand that a car must ascend almost all highway grades on high gear. This demand has brought about the general use of somewhat slower axles than were common some years ago, with greatly increased engine-speeds and vibration difficulties. In consequence of the slow axle-ratios, the engine, in many instances, is not doing its work at the most advantageous point of the horsepower curve.

Effect of Various Rear-Axle Ratios

Let us now consider the effect of various rear-axle ratios in terms of revolutions per minute of the engine plotted against miles per hour of the car, and then study it with relation to the torque and horsepower curves, which for convenience have been laid in on the same chart. The curves in Fig. 4 relate to a car weighing 4000 lb. in a closed model with complete equipment including bumpers and spare tire, filled with gasoline, oil and water, ready for the road. It has 30.00 x 6.75-in. tires, and a rear axle ratio of 4.8 to 1.0 was standard for this car with its usual three-speed transmission. It is reasonable to assume in any given case that the car builder has gone through a period of experimentation and has decided upon a rear-axle ratio that is the general average of his customers' demands and of the performance he purposes to sell with his car.

Assuming a road speed of 65 m.p.h. which this car could do readily, it will be noted that in fourth-speed with the 4.8-to-1.0 axle the engine runs at 3500 r.p.m. and that at this engine speed the horsepower curve is considerably past its peak. Examining next the curve for a 3.5-to-1.0 axle, it is found that for this same 65-m.p.h. road speed the engine runs at only 2560 r.p.m.

If a comparison of these figures does not mean much to the lay individual, a ride in the fast-axle car will be a revelation. Few persons want to drive at 65 m.p.h. but most operators expect to stay in top gear almost all the time, even in traffic. It was found, therefore, that a 3.5-to-1.0 axle in this particular installation was too sluggish for satisfactory performance in traffic. If the curves be examined at the 20-m.p.h. point it will be found that with a 3.5-to-1.0 axle the peak of the torque curve has not yet been reached and the horsepower curve shows 26-hp. although it is going up rapidly.

A 3.92-to-1.00 axle was tried but at the 65-m.p.h. speed the engine ran at 2860 r.p.m., which is a very near approach to the peak of the horsepower curve. This horsepower curve represents a dynamometer test under expert supervision and with everything going well. It is not to be expected that the engine could be made to show such results after the car has been in the hands of the owner for a few months. Furthermore, at that speed there was a little too much indication of high-speed vibration. Consequently a ratio of 3.69 to 1.00 was settled upon finally. The engine speed for 65 m.p.h. was then 2700 and the engine developed sufficient torque at low speed for the car to be handled satisfactorily in traffic without shifting gears unless one wanted to accelerate very rapidly.

Third-Speed Improves Acceleration and Climbing

Let us consider now the third-speed performance for this same set of conditions, with a ratio of 1.4 to 1.0 through the internal-gear train. For brevity we will examine at this time only the conditions for the 3.69-to-1.00 axle. For acceleration at speeds of about 20 m.p.h. we are at the peak of the torque curve, and for climbing long mountain grades at 35 m.p.h. the torque curve has not dropped off much and the horsepower curve shows about 68 hp. It will be noted further that the performance in third-speed with the 3.69-to-1.00 axle is much better for purposes of acceleration and hill climbing than that indicated by the curve for the 4.8-to-1.00 axle originally in the car, when driving in high speed, particularly

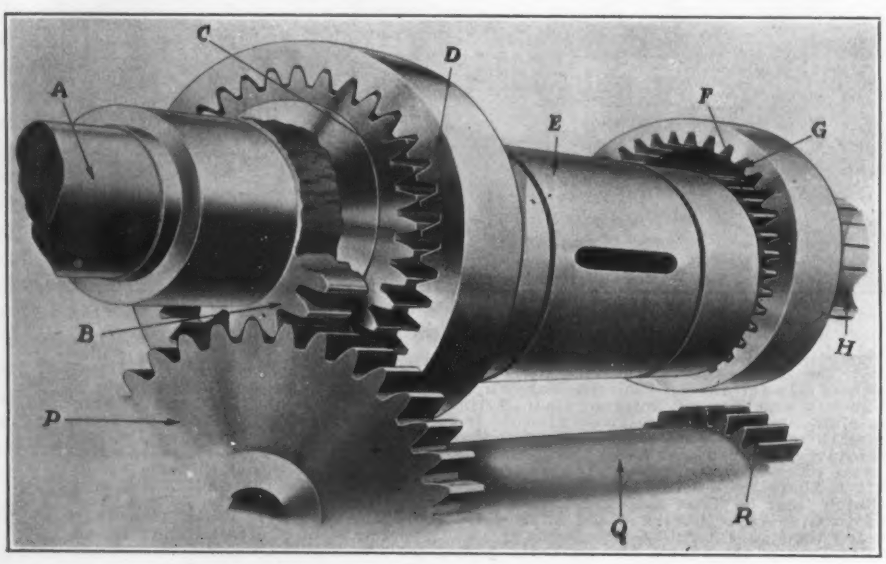


Fig. 3—Relation of Internal-Gear Train and Forward Portion of Countershaft

The Countershaft Cluster Has a Rather Long Hub *Q* that Clears the Space Taken Up by the Internal-Gear Train, and behind This Hub Are the Usual Gears for Second and Low Speed, all Cut from the Same Forging, as at *R*. These Mesh with Sliding Gears on the Splined Portion *H* of the Main Shaft. The Countershaft Drive-Gear *P* Is in Mesh with the Main Drive-Gear *B* on the Head of the Flywheel-Clutch Shaft *A*

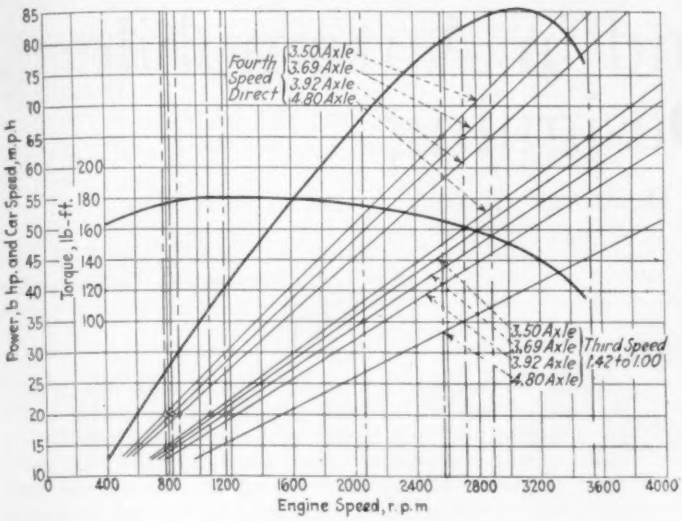


FIG. 4—RELATION OF REAR-AXLE RATIOS TO ENGINE HORSEPOWER AND TORQUE IN A 4000-LB. CAR

Weight of the Car Complete for the Road but without Passengers Was 4000 Lb. and It Was Equipped with 30.00 x 6.75-In. Tires. With Standard Direct-Drive Rear-Axle Ratio of 4.8 to 1.0 and a Car Speed of 65 M.P.H., the Engine Speed Is 3500 R.P.M., Which Is Considerably Past the Peak of the Horsepower Curve. With an Axle Ratio of 3.5 to 1.0 and at the Same Car Speed the Engine Runs at only 2560 R.P.M. and the Car Was too Sluggish in Traffic at Low Speeds. With the Axle Ratio of 3.69 to 1.00 Finally Chosen, and at a Speed of 65 M.P.H., the Engine Runs at 2700 R.P.M. and at Low-Speed It Develops Sufficient Torque for Satisfactory Car Operation in Traffic without Shifting Gears. Third-Speed Performance for the Same Set of Conditions, with a Ratio of Total Reduction of 1.42 to 1.00 through the Internal-Gear Train and the 3.69-to-1.00 Axle, Shows that at Speeds of about 20 M.P.H. the Engine Is Running at the Peak of Its Torque Curve and that for Climbing Long Mountain Grades at 35 M.P.H. the Torque Curve Has Not Dropped Much and the Horsepower Used Is about 68

when it is taken into account that the total ratio in third-speed is 5.24 to 1.00, which gives an added mechanical advantage.

Another set of conditions is shown in Fig. 5. This represents a smaller car, which weighs, complete, 3300 lb. and is fitted with 30 x 6-in. tires. This car was equipped originally with a 4.6-to-1.0 axle. At 60 m.p.h. the engine ran at 3260 r.p.m. and was considerably beyond the peak of the horsepower curve. After trying various ratios, 3.75 to 1.00 was settled upon, although 3.83 to 1.00 was also very satisfactory, except that it ran the engine a little too fast at high road-speed. With the 3.75-to-1.00 axle and the car traveling at 60 m.p.h. the engine ran at 2660 r.p.m., at which speed it was fairly well below the peak of the horsepower curve.

As for acceleration and hill-climbing ability in third-speed, it will be noted that at 35 m.p.h. with the original 4.6-to-1.0 axle, in high speed, the engine runs at 1900 r.p.m. and develops 50 hp. With the 3.75-to-1.00 axle and driving in third-speed, the engine runs 2200 r.p.m. and develops 57 hp.

This difference may not appear to be great but this increase in horsepower plus the mechanical advantage of the lower total ratio in third-speed of 4.60 to 1.00 compared with 5.32 to 1.00, represents the difference between forcing a car up a long mountain grade which taxes it almost to the limit of its ability, with the engine laboring, heating and giving every evidence of distress, and of going smoothly up the hill in third-gear with no strain on the engine and no anxiety on the part of the occupants of the car that the engine may stall at any moment. Suppose, however, that the driver has shifted to second-speed in the conventional three-speed transmission while ascending such a grade or one that he knows the car cannot climb in high speed. With the original 4.6-to-1.0 rear-axle ratio and 1.9-to-1.0 second-speed in the transmission of this car, to maintain a speed of 35 m.p.h. up-hill he must run the engine at about 3600 r.p.m., which is far beyond the speed of best performance for the engine. The engine will be overheated and suffer from vibration because of the extreme speed and will do this to the tune of the constant howl of the second-speed gears. When the driver reaches the top of the hill and decides to go down the other side in second-speed, the suffering engine is given a rest, but the noise in the transmission will not be diminished; it may even be increased, since transmission gears usually are noisier on their coast side than they are on their drive side.

THREE-SPEED-TRANSMISSION STEPS TOO LARGE

The fact is that usually too great a gap exists between direct and second-speed in the customary transmission to give the best hill-climbing results. If, on the other hand, the ratio of second-speed were such that the car would show the best performance on hills, the ratio would not be so satisfactory for starting on the level in traffic, and the gap between first and second-speeds would be too great for good gear-shifting results.

As an illustration of how marked a difference in hill-climbing ability a small difference in gear-ratio makes, I shall describe our experience on a hill with the car to which Fig. 5 applies. The hill is 7/10 of a mile long, with grades ranging between 10 and 18½ per cent, and such sharp turns that it is not safe to drive much faster than 30 m.p.h. The road has a gravel surface and leaves the main highway sharply at the foot of the grade in such a way as to present no opportunity for a running start at a speed of more than 25 to 30 m.p.h. The car with its original ratio could not do much more than get started up the hill in high-gear, although it had no diffi-

(*Concluded on p.* 769)

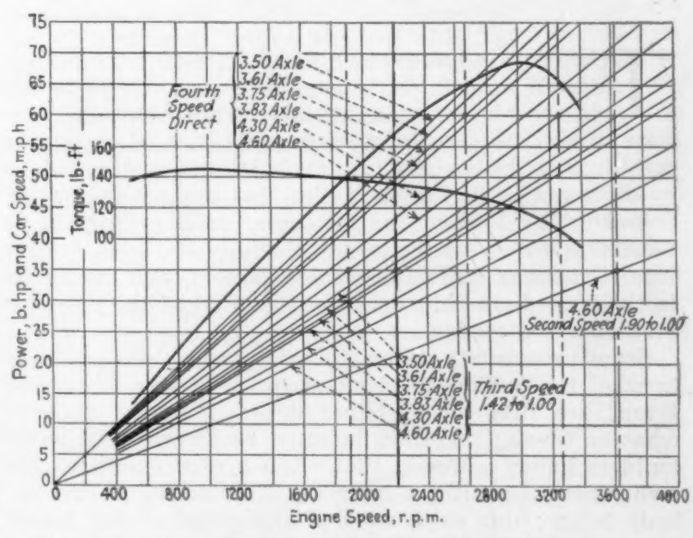


FIG. 5—RELATION OF REAR-AXLE RATIOS TO HORSEPOWER AND TORQUE IN A 3300-LB. CAR

As Originally Equipped with 30x6-In. Tires and a Rear-Axle Ratio of 4.60 to 1.00, the Car, When Driven at 60 M.P.H., Required the Engine to Run at 3260 R.P.M., which Was Considerably beyond the Peak of the Horsepower Curve. When an Axle with a Ratio of 3.71 to 1.00 Was Substituted the Engine Ran at 2660 R.P.M. in Fourth-Speed for the Same Car-Speed, and This Was Fairly Well Below the Peak of the Horsepower Curve. In Third-Speed with the Original Axle, at a Car Speed of 35 M.P.H., the Engine Ran at 1900 R.P.M. and Developed 50 Hp., while with the 3.75-to-1.00 Axle It Ran at 2200 R.P.M. and Developed 57 Hp. The Additional 7 Hp. Plus the Mechanical Advantages of a Lower Total Ratio in Third-Speed of 4.60 to 1.00 Compared with 5.32 to 1.00, Represents the Difference between Ascending a Hill in Third-Speed Smoothly and without Engine Stress and Forcing It Up at the Limit of the Engine's Ability

Tomorrow's Trend in Automobile Body Designing

By R. H. Dietrich[1]

Annual Meeting Paper *Illustrated with* Drawings

ABSTRACT

POSSIBILITIES are greater today than ever before for designing bodies that are well proportioned to the chassis and pleasing in appearance. Designers are uncertain, however, what the public will demand. The author asserts that governing factors will be low appearance, good proportions, harmonious exterior coloring and comfortable seating. Simplicity will be one of the more refined points in body trend, and soft pastel shades in finish are coming into vogue.

Several ways of expressing lowness may be attained by the use of belt and body-sill moldings, which may extend through the bonnet to the radiator; by the use of a crown of 5 to 6 in. in the roof; by dropping the roof at the rear corner; by increasing the depth of the door-heading from 2¼ to 2½ in.; and by making the windows wider than they are high. In brief, "cheat lines" that are now employed to deceive the eye will carry the vision along extended longitudinal lines.

The time has arrived when the chassis engineer must help the body designer to produce better-looking cars, the author holds. Pedals and steering-wheel must be placed farther forward on short-wheelbase chassis to provide comfortable seating and riding qualities without the necessity of extending the body so far to the rear that the doors must be cut away to clear the rear-wheel housings, and to prevent cramping in the entrance. Adjustable driving-seats must be developed so that persons of different stature can drive in comfort and so that the position of the driver can be changed on long rides to relieve tired muscles. Rear spring-suspension needs attention to avoid the high throw-up at the rear during the nine-tenths of the time when the car is operated without full passenger-load and also to eliminate or to reduce the kick-up at the rear axle, which now determines the angle of the rear seat and limits the depth of the cushion springs.

Decorative interior treatment is changing rapidly and, while it is impossible to guess what the demand will be, the public is becoming educated to finer and softer materials. Simplicity will govern the treatment of accessories and hardware. Vanity cases and over-elaborated metal trimming will be eliminated.

Whether the trend in exterior colors will be toward harmony or contrast is hard to decide, as this is largely a matter of mental attitude on the part of the buyer. The author advises the use of color contrasts and extreme harmonies during a period of prosperity and high spirits, and of somber colors in a period of depression. Colors, and their combination and arrangement, that are suited to large high-priced cars may be entirely unsuited to small low-priced cars and, moreover, some colors cannot be properly applied by the class of labor that must be used on the low-priced cars.

THE future has greater possibilities for the designing of automobile bodies than ever existed before in the history of automotive transportation, I believe, and there are as many possibilities of designing good-looking bodies that are proportioned to the chassis as there are of designing bodies that are not so proportioned. The demand for low cars, good proportion in design, harmonious exterior coloring, and comfortable interior seating will be governing factors with the public in the immediate future and in the mind of the designer of distinctive models.

Some uncertainty seems to exist among designers as to what the public will demand in the design of bodies. I am sure that the customer does not know precisely what he wants; therefore he must be shown. All body-builders know, however, that when a man expresses his own ideas regarding a body he is becoming a custom-body buyer; this expression of individual choice places him in a special class of car owners.

Various Ways of Expressing Lowness

Several means may be employed to express height or lowness in the external design of an automobile, and to determine whether moldings are to be used or are to be dispensed with entirely. The body designer has better opportunities today than he had in the past because the chassis designers are now steadily and practically expressing their ideas with low chassis. A low chassis is one of the essentials in obtaining a low and well proportioned complete-car design.

I am sure that the double belt-molding will be replaced by a single molding which will, perhaps, extend all the way around the body and through the bonnet, or may be terminated at the base of the windshield. Another way of expressing lowness is by a molding at the body sill, either continued through the bonnet or stopped at the bonnet and ending at the wheel-housing. I have tried various dimensions, from ¾ to 4 in. wide, and can affirm that the larger the molding is the lower and longer the entire design appears to be.

Crown of the roof is another governing factor in expressing lowness. A crown of from 5 to 6 in., with proper contour across the roof, will eliminate the bulky appearance that a heavily crowned roof sometimes has.

Size and proportion of the glass also determine to a considerable extent the apparent height of a body. Height of the lower vision-line with proper relation to the cowl, bonnet and radiator has an important effect, as does also the depth of the door-header. Designers always have had the idea that a door-header must have a certain dimension from 1⅜ to 1¾ in. deep, but, if the header-rail is made 2¼ to 2½ in. deep, it expresses lowness by making the proportion wider than it is high and does not cheat the height of the entrance. The effect of the foregoing points is made evident by a comparison of the two sketches in Fig. 1.

Appearance of the car from the rear is greatly im-

[1] Dietrich, Inc., Detroit.

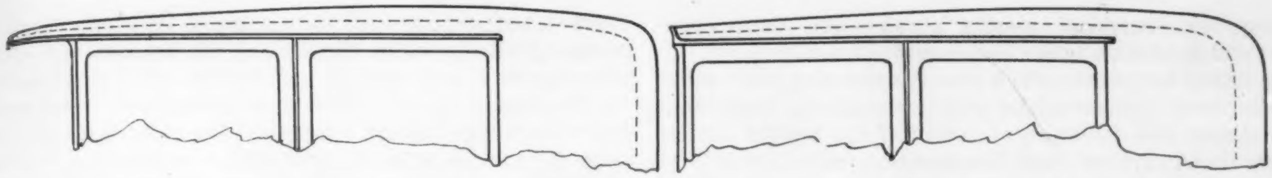


Fig. 1—Comparison of Treatment of Lines in Body Superstructure To Show How Appearance Is Altered
In the Drawing at the Left the Present Method of Crown and Roof Development Is Followed. The Dotted Line Shows the High-Light through the Roof and Rear Quarter. The Visor Extension Is Retained and the Door Headers Are Narrow. In the Drawing at the Right the "Cheat-Line" Method of Treatment of the Roof Line and High-Light Is Followed. The Rear Corner Has More Drop, the Visor Is Eliminated and the Door Headers Are Deeper. These Modifications Give the Body a Lower Appearance

proved by dropping the roof at the rear corner, or by making use of the bald face. This type of construction takes into account the allowance which the chassis designer must make in his original plan for spring action of a fully loaded car. Since nine-tenths of the time that the car is in use it is loaded only from one-third to two-thirds of its carrying capacity, the car may seem to have the appearance of tilting slightly forward. This appearance is due, of course, to the excessive spring spread in a partially loaded car. Therefore, dropping of the roof-line, as at the right in Fig. 1, takes away from the apparent height of the body at the rear when it is not fully loaded.

Clear-Vision Posts Without Seeming Frailty

One of the main features that should not be overlooked in design is the clear-vision post. The tendency of the designer has been to make this look as light as possible from the side view. It is possible, however, to design a post that will not obstruct a greater angle of vision than a narrow post and yet will not look very light from a side view. This can be accomplished by a design treatment that is best adapted to the type of body into which the post is built.

When State laws require the designer and builder of automobile bodies to take away the heavy vision-obstructing construction at the sides of the windshield, the insurance companies must necessarily reduce the premiums on liability insurance. Any such reduction will be a considerable item to the buying public.

In addition to elimination of the heavy corner-posts we have to dispose of the visor. The extended-roof visor has gone, and there is no likelihood of its return into use again. The added visor that has been placed on automobiles will also depart as soon as some builder has the courage to leave it off. This belief was expressed by several manufacturers at the New York Automobile Show last January. I am sure that proper treatment in design at the windshield-header will help, as in Fig. 2, to eliminate the cumbersome appearance that now exists. This detail will have to be worked out, and the upper front will need to be proportioned line for line with the rest of the body.

Simplicity will be one of the finer points in tomorrow's trend in motor-vehicles. Cheat-lines will be developed and used more than ever before. By "cheat-lines" I mean lines that deceive the eye. Heretofore we have always designed automobile bodies to conform to the extreme lines of the car; now we shall have to forget these lines and employ lines that deceive the eye. How often one sees two cars of the same height standing side by side, yet one of which looks much higher than the other. Clever observers can readily note that the car which seems lower was designed and developed on the cheat-line system. This originated in France many years ago, when the first developments in body proportion were started, and was adopted and used for many years by custom-body builders.

How Chassis Engineer Can Help

Length on the chassis for the body is very important in obtaining good proportions in the body, and I think the chassis engineer should give some study to the position of pedals and steering-wheel behind the dash. Years ago, when drivers sat up high, the engineers decided that the only way in which they could make possible the building of lower bodies was to incline the steering-post more and extend the pedals in proportion. This change of position helped to bring the body height down but did not improve seating conditions. On the contrary, it shortened the distance the body designer had to work with and failed to provide for the demand that is developing for short-wheelbase chassis without any sacrifice of comfort in seating. These demands cannot be met without the aid of the chassis engineer. The body designer has been forced to extend the body far beyond the rear fenders and make a large cut in the bottom of the door at the wheel-housing, thereby cramping the entrance to

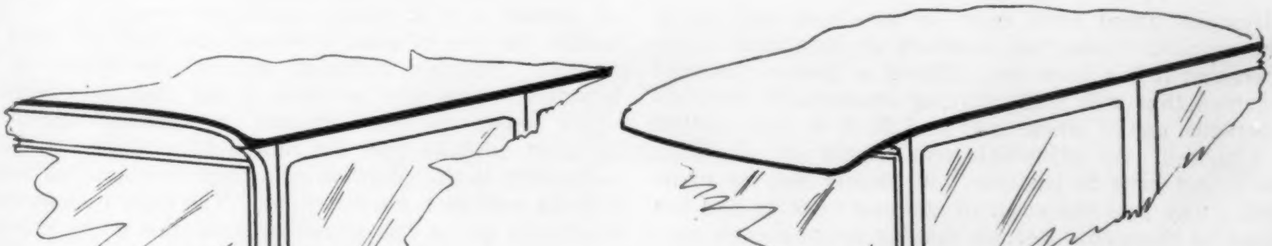


Fig. 2—Contrast in Treatment of Upper Front of Body
In the Drawing at the Left the Roof Extension, or Visor, Is Omitted and a Molding Treatment at the Windshield Header Relieves the Cumbersome Appearance That the Roof without the Visor Would Otherwise Have. The Corner Post Is Given a Substantial Appearance without Increase of Obstruction to Vision. At the Right the Appearance of Present Bodies with Visor Is Shown for Contrast

the rear compartment, merely because the chassis engineer did not think quite far enough ahead.

The time has come when the chassis engineer must help the body designer, not only by suitably arranging the distance and direction of travel of the pedals but by setting them farther into the engine compartment and also by bringing the steering-wheel closer to the dash. These changes will not alone make possible a better seating arrangement but will also give the chassis better design and proportion.

Some consideration must also be given to the clearance between the rear axle and the chassis frame so that the car will not have the appearance of making a nose dive when it is going along the street. Most of the time a car is occupied by only two persons, and nine-tenths of the time it is not fully loaded. With spring deflection designed for a full load, the blame for the lack of comfortable riding-qualities has been placed on the body designer and builder in such phrases as, "The cushion springs are not proper for this car," "The seat has a tendency to pitch me forward constantly," and "At the end of a ride of 50 to 75 miles I am tired out." How can this condition be remedied without the aid of the chassis engineer, when the springs are designed for full load? With the help of the chassis engineer in the matter of pedals, steering-post and rear springs, the body builder can produce a motor-vehicle that will not only give greater comfort but that will also have better riding-qualities.

To Make Seats More Comfortable

Adjustable front seats must be developed and placed on the market. Today all members of the family drive the car, and it has been very difficult to design standard dimensions that will make driving comfortable for several persons, one of whom may be 5 ft. 8 in. and another 6 ft. 2 in. tall. An adjustable seat should not only slide forward and back to position, but should also be made in such a way that the angle of the seat cushion and the back can be changed. Besides making driving more convenient for persons of different stature by changing the position of the seat, this adjustable feature will give the driver greater comfort on a long ride and will relieve the muscles that have become stiff from sitting too long in one position.

As for height and thickness of cushions, how can anyone determine what he or anyone else will like tomorrow? Standard dimensions for cushions existed formerly and were often determined with regard to position at the steering-wheel, while the height of the springs in the rear cushion was determined by the amount of kick-up in the chassis frame. The chassis engineer must realize how the high kick-up influences the rear seat and how impossible it is to give the cushion and back a comfortable angle when the position and height of the cushion springs are determined by that one factor. Comparison of the sketches in Fig. 3 shows a method of treating kick-up to provide for more comfortable seating.

Interior treatment, including leather, cloth and hardware, is changing so rapidly that it is impossible to guess precisely what will be in demand, but I am sure that tomorrow will present greater possibilities because the public is becoming better educated to finer and softer products. Simplicity will prevail, and vanity cases will be eliminated, as every woman now carries her own.

Psychology in Exterior Coloring

If I could explain the trend in exterior coloring, determine what colors would be used most during the coming year and choose the colors that would make each car individually a success for its sponsor, I should be worth a considerable sum of money to the manufacturers of automobiles. The changing of colors, with the inviting pastel shades, contrast and harmony that the makers of paints have expressed in their color books, render it very hard to decide whether the trend is likely to be toward harmony or contrast. I think the trend will be determined largely in the mind's eye of the public.

With a period of depression, I would advise the use of somber colors; with a spirit of prosperity, I should advise the use of color contrast and extreme color harmonies. As for different shades, one shade is best adapted to one type or style of car and body while another shade is best adapted to another style. The greatest mistake that the automobile builder is making constantly is the adoption of a color combination because it looks well on some other car. The sales managers and engineers go to the showrooms of the more expensive types of car and see a color combination on a car that costs from $10,000 to $15,000 and return highly enthusiastic. "Let us adopt that color scheme," they say, forgetting that the particular color combination and proportion are not adapted to their type of body.

The choice of color is limited, moreover, by the amount of money that can be spent for applying the color. Some colors are very costly and cannot be applied by the class

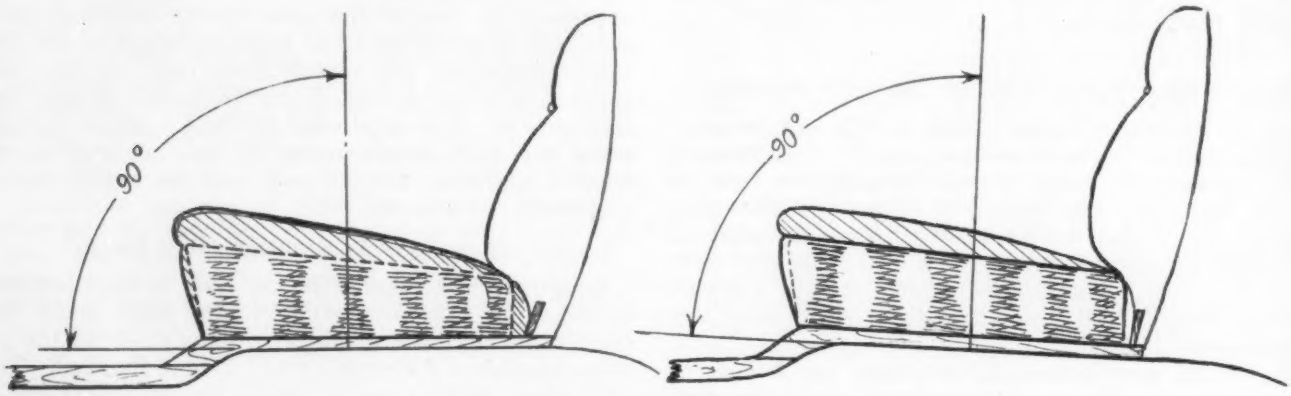


Fig. 3—How Kick-Up Affects Riding Comfort

With a Horizontal Kick-Up, as in the Drawing at the Left, the Spring Action in the Seat Cushion Is Vertical and Tends Constantly To Force the Passenger Forward on the Cushion. If the Kick-Up Is Inclined Backward as at the Right, the Spring Action of the Cushion Coincides with the Vertical Axis of the Passenger's Body and the Forward Thrust Is Absent

of labor that must be employed. The application of some colors requires an artist, a man with feeling, for depth and softness are expressed by the way in which the color is applied.

In my experience in building bodies men have come into my plant, have looked at color, harmony and proportion on cars ranging in price from $5,000 to $8,500 and have asked if that color scheme could be adapted to a car that was to be sold at about $1,000. Color harmony is considered when the body design is started, not when it is completed. We virtually make a color design with every body design to satisfy ourselves that the colors and their arrangement are suited to that particular design of body.

Finally, I wish to leave the thought in mind that pastel shades are coming into vogue. They will be used more in the future than they have been in the past because they have softness.

INTERNAL GEARED FOUR-SPEED TRANSMISSION

(Concluded from p. 765)

culty in climbing all the way to the top in second-speed. The total reduction of rear axle times transmission second-speed was 8.75.

Later, when the car was equipped with the four-speed transmission and the 3.61-to-1.00 axle, it was possible to climb about two-thirds of the way in third-speed. It was then necessary to shift back to second-speed for about 100 ft. to speed up the engine and secure enough additional headway for the car to make it possible to finish the hill in third-speed. The total ratio of rear axle times third-speed reduction in this instance was 5.12.

The next trial was made with a rear axle with a ratio of 3.75 to 1.00 which gave a total reduction in third-speed of 5.32. This slight increase of 0.20 in reduction was enough to take the car up the hill without difficulty, and even when climbing at slow road-speeds and with the engine developing little horsepower, it was possible to stop the car at any place on the hill, start in second, shift into third at 5 m.p.h. and continue without any difficulty or signs of engine distress, laboring or overheating.

To summarize in conclusion, the purpose of a four-speed transmission with a direct fourth-speed and internal-geared third-speed is to make a fast rear-axle practical and workable. The purpose of the fast rear-axle is to reduce the speed of the engine and propeller-shaft. The purpose of this reduction in rotative speed is to push various periodic vibrations and the high-speed rattle up to such fast road-speeds as to be rarely encountered, and thus we accomplish what we set out to do.

In addition, consequential benefits are secured that are even more desirable. The slower engine-speed and reduction of vibration mean much longer life for the engine, chassis and body, greater driving comfort for the passengers, greatly improved gasoline and oil mileage and better cooling. They mean practical elimination of propeller-shaft whip, a single axle-ratio for all parts of the Country, and better all-around car performance due to utilizing a more favorable portion of the horsepower curve. Each and all of these the industry has constantly sought to attain or improve by various methods, to the end that we may have better automobiles. Finally, while it is not really the intention to increase the attainable top driving-speed, the four-speed transmission does sometimes accomplish this. What is better and safer, it increases the average driving-speed, because the driving is so smooth and the sense of speed so different that one unconsciously covers more ground in a given time and with less bodily fatigue and nervous strain.

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Theory and Method of the New Haven Railroad's Highway Operation

By A. P. Russell[1] *Discussion of* Transportation and Service Meeting Paper

The discussion following the presentation of this paper at the Transportation and Service meeting of the Society that was held at Boston in November, 1926, was almost entirely oral, only one written contribution having been received. The author was afforded an opportunity to submit a written reply to the points made in the discussion and the various speakers were provided with an edited transcript of their remarks for approval before publication. For the convenience of the members a brief abstract of the paper precedes the discussion so that those who desire to gather some knowledge of the subjects covered without referring to the complete text as originally printed in the December, 1926, issue of The Journal *can do so easily.*

ABSTRACT

The New Haven Railroad Company, having found, as the result of a survey, that competition by motorcoaches was seriously affecting its passenger revenue, took steps to protect itself. After several decisions of State supreme courts and of the United States Supreme Court had given the railroad company authority to operate motorcoaches over the highways, a subsidiary of the railroad, known as the New England Transportation Co., was formed. This company during the last summer has operated 37 through routes and utilized 168 motorcoaches, about one-half of which have been used in service superseding that of the railroad.

The policy adopted by the New Haven Railroad in the operation of its motorcoach lines is explained and the results that have been obtained are described. Better and more frequent service is said to be rendered at a considerable saving in the cost of operation per mile. The question of public necessity has been developed in the public mind to the point where it sees that this necessity affects not only the branch-line service but the very essential freight and through service that must be maintained in southern New England, if that section is to continue to prosper. The public now appreciates that whatever conserves established transportation organizations at the same time maintains permanent satisfactory transportation service.

In the discussion, the effects of motorcoach service on the steam-railroad service between Camden and Atlantic City, N. J., are outlined; factors influencing the adoption of the motor-vehicle by the electric railways are enumerated; one railroad's practice as to complete substitution of motorcoach for steam-train service is stated; the value of expert consultant service to further the extension of motor-vehicle service is argued; the factors of motor-vehicle and railroad coordination are presented; and a pertinent query is propounded as to whether the motor-truck actually has arrived.

THE DISCUSSION

H. C. Crowell[2]:—I was particularly impressed by Mr. Russell's description of the highway-transportation operations of the New York, New Haven & Hartford Railroad. He says: "The first motorcoach took the place of branch-line service." In my opinion this is just the place to begin.

There are many conditions under which motorcoach service should not be installed. We railroaders who live in the East realize that only too well. In three directions out of Philadelphia there are motorcoach lines that, in my opinion, have no legitimate excuse for existence. For instance, between Philadelphia and Atlantic City there are six or eight lines paralleling three double-track main-line railroads, two steam lines and one high-speed electric-line, all giving adequate transportation from the viewpoint of both quality and quantity. In a letter from President A. T. Dice of the Philadelphia & Reading Railroad Co. to the Mayor of Atlantic City, N. J., concerning the operation of motorcoaches between Philadelphia and Atlantic City, President Dice reviews the large expenditures of his company in improving the equipment and the service between Philadelphia and Atlantic City and then goes on to say:

> We have ever been hopeful, however, of the future of Atlantic City and the other seashore resorts, and naturally expected to participate in a normal increase in traffic and thus enjoy the fruits of our efforts, but we are now faced with the possibilities of the present type of unrestricted motorcoach competition using public highways and streets for running ground and terminals.
>
> It is not to be conceived that the combined motorcoach operation could safely handle the peak summer or holiday crowds, or that the regular commuter, the backbone of summer prosperity and realty advance, would rely upon slow motorcoach-transportation. In a 3-day period, recently, over 500 motorcoach trips were counted in and out of Atlantic City, nearly all of which were en route between points served by our railroad, chiefly Philadelphia and Atlantic City, and the amount of business handled by the motorcoaches is sufficient to lower the average business of the railroad to such an extent that the maintenance of the present schedule is problematical and a continuance of large capital expenditures unjustifiable.

The motorcoach has its own particular fields, such

[1] Vice-president, New York, New Haven & Hartford Railroad Co.; president, New England Transportation Co., Boston.

[2] Assistant to the chief engineer, Pennsylvania Railroad Co., Philadelphia.

as local-transportation agencies in metropolitan areas or as lateral feeders to rail lines in outlying districts or as a means of continuing transportation service in territories where travel is light by the intelligent substitution of highway service for lightly patronized local rail facilities, coordinated with express service, or as a modern means of developing new territories along the lines the railroads used in building up their traffic. Generally, we do not believe they should go much further except in unusual cases.

The public will have to decide as to whether it can afford to provide roadway and terminals for these highway lines, particularly those which seek to duplicate and possibly replace adequate railroad-service gradually developed over a long period.

I do not overlook the fact that in the end the public will have its way and if it prefers to ride on rubber rather than on steel, it will do so, although there are conditions under which it cannot do both, and one method must give way to the other. On the other hand, there are many conditions under which motorcoach service is the proper method of transportation. Some of these conditions are:

(1) Serving sparsely settled territory that has no transportation by the operation of motorcoach lines in lieu of building new branch-lines or extending existing branch-lines
(2) Improvement in existing transportation-service in fairly well built-up territory by the operation of motorcoaches parallel with the rail line between cities, collecting passengers from intermediate towns for express trains that will stop at the motorcoach terminals, thus substituting express service for local service and benefiting all concerned
(3) The operation of motorcoaches in sparsely settled territory where the operation of steam trains is unprofitable, thus dispensing with part or all of branch-line passenger-service, benefiting the existing carrier and giving the public equally good or even superior service

In my opinion service (3) is the most profitable field for the use of motorcoaches that is open to our established carriers.

On the Pennsylvania Railroad we have a committee studying the operation of our branches. Many of these short lines were originally installed as feeders. Possibly that is a good name for them, as they "feed" upon the main line. They are not feeders in the usual meaning of that word, and I prefer to call them bleeders. To get rid of all these branches that have no economic reason for existence is not only undesirable but, under the law, it is impossible. Communities have grown up along these branches and while they do not furnish enough traffic to make them profitable, either directly or as a feeder proposition, they probably are entitled to some kind of service. If they are abandoned we would obtain a net salvage of possibly $2,000 per mile, which is frequently less than 5 per cent of the cost of building these lines. The cost of maintenance and operation, however, frequently indicates the advisability of asking the Interstate Commerce Commission for permission to abandon them; but, before taking this step, we try to find some method of economizing in the operation that will justify the retention of the track. Frequently, the elimination of passenger losses will change a net deficit into a net income. This indicates the advisability of holding the track for the freight movement.

A year or two ago it was generally considered by railroad engineers that, when the freight movement required the maintenance of the rail line, the use of a motor rail-car propelled by a gasoline engine, a steam powerplant or some other self-contained power-unit, would solve the passenger problem. At present, we are inclined to doubt the wisdom of that statement. The operation of gasoline motor rail-cars may cost a little less than a steam-train service and, in some few cases, substantial savings may be made, but it is true, however, that in many cases they prove to be merely temporary expedients. Three items of expense in their operation are outstanding: overhead, labor and fuel. The overhead, including interest and depreciation, is high because of the great initial cost; some of our motor rail-cars have cost more than four times as much as a 29-seat parlor motorcoach. Such a car must be put on a run of 200 miles or more daily if the overhead cost is to be kept within bounds. Labor is high on account of peculiar conditions in the railroad field that must be met. I refer not only to the high wage of the individual employe, but also to the number of employes necessary to man one of these cars. Generally, the wage of the fireman is the only saving compared with steam operation. Fuel is high because we do not get satisfactory mileage per unit of fuel consumed. Some of our largest cars cover only from 1 1/3 to 1¾ miles per gal. of gasoline, with the result that the fuel cost may equal or even exceed the cost of coal for operating a branch-line passenger-train. This, of course, may not be true in a locality where gasoline is cheaper and coal more expensive than they are in Pennsylvania.

As a comparison I will state that the out-of-pocket cost of motor rail-car operation is seldom less than 40 cents per mile and may reach 80 cents per mile under unfavorable conditions, while the branch-line passenger-train costs, out-of-pocket, from 80 cents to $1 per train mile. It is therefore logical to turn to the motorcoach as a substitute for the unprofitable branch-line passenger-train. Motorcoach operation, we are told, varies from 25 to 35 cents per mile and is, therefore, much less expensive than either train or motor rail-car. Furthermore, it is more flexible, it satisfies the traveling public, it does not require a great investment, and it may serve to change an unprofitable branch into a profitable one, thus retaining adequate freight-service by rail that otherwise might have to be sacrificed. Even though the motorcoach may not pay its way, it may serve to reduce total expenses so that the sum total of passenger and freight operations may be on the right side of the ledger. It seems to me, therefore, that Mr. Russell's statement that his first motorcoach operation replaced branch-line train-service is exactly what should be expected. That is where motorcoach service logically should begin. I would not go so far as to say it should end there, as I have already mentioned other fields where it can be used economically; but the greatest savings, in my opinion, will be made along the branch line.

Motor-Vehicle Adoption by Electric Railways

J. S. Bleecker[3]:—Unfortunately, the proportion of steam-railroads that are as advanced in the adoption of the motor-vehicle as is the New York, New Haven & Hartford Railroad is comparatively small. Speaking from experience in the electric-railway field only, about 40 per cent of all the electric railways in the Country have adopted the motor-vehicle. One reason that they have done so to a greater extent than have the steam-railroads is to save their lives. The steam-railroads have a greater margin of safety in that regard. In the electric-railway field it became necessary in some instances

[3] M.S.A.E.—Consultant, Day & Zimmerman, Inc., Philadelphia.

to do something very quickly and very drastically. Out of the 40 per cent of the electric railways which have adopted the motor-vehicle only 12 per cent have been obliged to substitute the motorcoach for the electric railway in its entirety. The substitution in its entirety of motorcoach for electric railway constitutes about 3 per cent of the total number of motorcoaches and slightly less than 3 per cent of the total mileage which electric railways are operating in motorcoaches. But many of them have awakened to the seriousness of the situation in time to save their lives and the others are fast awakening as is indicated by the trend of the curve from year to year of the electric railways which are adopting the motor-vehicle auxiliary. Many of the following statistics are from an interesting article on Why Some Electric Railway Lines Have Been Discontinued[4], by Edmund T. Murphy, chief statistician of the American Electric Railway Association.

It will be a comparatively simple arithmetical problem if we reduce an interurban railway say 50 miles long to its basic elements. After reducing valuations to the bare bones, one might have an investment of $30,000 per mile for an interurban railway through a country territory with comparatively little city work. It requires 6-per cent interest, which is low; 3-per cent depreciation, which is low; and 1-per cent taxes for a 10-per cent return on $30,000 per mile as a fixed charge after operating expenses are deducted. Without that as the minimum percentage, the railway might just as well go into receivership.

Assume that a return of $3,000 per mile is the minimum and assume also that an interurban railway of such character has, through the competition of automobiles, been reduced to gross passenger-earnings of $10,000 per mile of track. To have the $3,000 per mile for a fixed charge, the railway must operate for $7,000 or 70 per cent of the gross passenger-earnings, which is a very low operating-percentage. Hence, when an interurban railway reaches that status, if anything depletes its earnings further, some very serious results will follow.

Assuming that this electric railway is paralleled by a well-paved highway on which it is evident that motorcoaches can be operated and that the public is demanding such service, and also assuming a competing line starting up over this 50 miles of highway at an average speed of 25 m.p.h., the competing line easily can supply this service with seven motor-vehicles, five for service and two for reserve, with a $100,000 investment; $70,000 for equipment and $30,000 for garages. We know that the competing line can live on gross earnings of $100,000, which is $2,000 per mile, taking business from the interurban railway, which is already established, and furnishing a duplication of the hourly service between terminals. What happens to the electric railway? Its revenues are reduced from $10,000 to $8,000 per mile, its operating expenses are not reduced and the services must be maintained as before; therefore, its operating expenses are still $7,000, and it has a margin of only $1,000 instead of $3,000 per mile. That leaves about 3 per cent to take care of fixed charges, depreciation and taxes, which is financially impossible.

On the contrary, suppose this interurban railway installs its own motor-vehicle service. Not only does it retain the $10,000 per mile, but it puts the motor-vehicle service on a ½-hr. schedule in between the hourly schedule of its own electric-railway cars, thus attracting back to itself another $2,000 from the motor-vehicle passengers and increasing the gross receipts to say $12,000 per mile. The operating percentage rises from 70 to 73, and $3,200 per mile is left to pay fixed charges, which is 10 per cent of $32,000 per mile, the sum of the $30,000 per mile for the electric railway and $2,000 per mile for the motor-vehicle line. Those are elementary figures, but they are so true and they have such similarity in so many instances that it seems that much more than 40 per cent of the electric railways should have studied this problem and adopted the motor-vehicle as an auxiliary.

The total number of motorcoaches now operated over 14,899 route-miles by the electric railways is 6556. Motorcoaches have been substituted completely for the trolleys by 12.6 per cent of the companies. The number of motorcoaches so substituted is 193, or 3 per cent of the total number of motorcoaches in use by electric railways. The mileage supplanted by motorcoaches is 404 miles, or 2.7 per cent of the total mileage. In other words, of the total number of 6556 motorcoaches, 6363 have been added to the service already being furnished by the electric railways in the form of feeder and auxiliary service and have to that extent improved the service furnished to the public.

Referring to the feeder lines mentioned by Mr. Russell and considering some of the criticisms and arguments which are being advanced today by one carrier against another in some parts of the Country where they attempt to interfere and injure each other by operating some services at a loss to retain monopolistic control, I believe it is reasonable to assume that, in conjunction with the electric railways and with steam-railroads, motorcoaches might be operated at a definite and distinct loss if they acted as feeders for the long-haul profitable-business which must be maintained. I believe it would be about as unfair to condemn a transportation system that includes both rail and motorcoach service for operating one of its departments at a loss when the entire service is satisfactory and profitable as it would be to condemn a store handling many different kinds of goods for having "dollar days" or "penny" sales or for selling some goods below cost to attract business to the store; in other words, to put each department of a public utility on a definitely paying basis by itself is a very difficult problem.

It seems that ample precedent exists for contracting for passenger service on the part of steam-railroads, where the laws prohibit steam-railroads from doing that kind of business themselves. I presume that, in time, legislation will be enacted which will make that sort of thing unnecessary; but, at present, it may be legitimate to consider the possibility of contracting where the steam-railroad is not as fortunate as is the New York, New Haven & Hartford Railroad in being able to operate by means of its own subsidiary. I think all these motorcoach and motor-truck difficulties that the electric railways and the steam-railroads have been experiencing are very helpful.

Motorcoach Substitution for Steam Trains

R. E. Plimpton[5]:—What has Mr. Russell's company done in the way of complete substitution of the motorcoach for the steam train? I have in mind particularly steam-train services such as carrying baggage, mail and light express.

A. P. Russell:—On the motorcoach lines that are supplanting rail service wholly, there is a demand for a supplemental service of that character. All the motorcoaches in that particular branch of service have a

[4] See *Aera*, September, 1926, p. 183.
[5] M.S.A.E.—Associate editor, *Bus Transportation*, New York City.

compartment for baggage. On some of our lines we maintain a motor-truck to handle express and mail, but in most cases the mail is carried by some other form of transportation. We realize that in supplanting the rail service by motorcoaches it is necessary to give to the public everything which it would have if the rail service remained operative, and we endeavor to take care of that by handling the baggage, the express where necessary, the mail and the newspapers. To the extent that the passenger-carrying vehicle cannot do that, it becomes necessary to use a motor-truck for the purpose where the volume of business is sufficient to warrant such procedure.

BERNARD ALLEN[6]:—Has Mr. Russell's company substituted motor-trucks for rail service in cases in which the company is still forced to carry mail? In Canada, the Board of Railway Commissioners is empowered to force the railroads or any person to carry mail. The Board also can specify the time for carrying mail. The question has been raised in Canada as to whether trains which have been furnishing mail service can be cancelled. We have been allowed to cancel trains in many instances, but in some instances the Board has forced us to maintain passenger service on lines just on account of mail service.

MR. RUSSELL:—A theory existed for some years in the United States that the railroads were obliged to carry the mail. That point has been decided to the contrary by the Supreme Court[7]. In 1916 Congress passed an act obligating the railroads to carry the mail provided they received reasonable compensation, this to be fixed by the Interstate Commerce Commission and the mail to be carried on such trains as are operated.

CONSULTANT SERVICE ON MOTOR-VEHICLE EXTENSION

FRANCIS W. DAVIS[8]:—It has been remarked that, when the Boston & Maine Railroad launched into the motor-truck-transportation field, it was unable to obtain the basic facts and fundamentals on which to extend this service; further, that the assistance given by the motor-vehicle manufacturers, while it was freely given, was open to very serious criticism because these companies primarily recommend the purchase of additional equipment or such change-overs as usually involve the sale of more of the vehicles of that particular manufacturer. In such case, it seems that a field is opening up which calls for a very real service, that of acting as a consultant for the extension of motor-vehicle operation. A consultant in this field often is accorded a very short hearing in endeavoring to cooperate with the users or potential users of motor-vehicle equipment, but, through contact with various companies that operate from 20 to 3500 motor-vehicles per fleet, where the expenditures run from $1,000 to $4,000 per year per vehicle, it has been my experience in this field that it is possible in most cases to save from 10 to 15 per cent of the total operating-expenses by analyzing the fundamentals of the subject completely. I wish to point out that this kind of service is growing and the men who are progressing in it naturally must have had a considerable amount of fundamental experience and of actual knowledge of fleet operation. A consultant in this work can help in matters having to do with equipment, operation, maintenance, administration, and costs; that is, the entire field of motor-vehicle operation.

In one fleet we found 44 different makes of motor-vehicle, the number of models of those different makes being something like 120. It is extremely difficult to carry out maintenance, inspection, cost accounting, and the general administrative work having to do with the operation of such a diversity of equipment. One of the important things to do is to endeavor to standardize to a reasonable degree which will permit very evident economies and yet will not rule out any development and progress made in the motor-vehicle industry. The average life of a vehicle in that fleet was 5 years, and the expenditure each year was approximately $1,000,000. We are endeavoring, with every show of success, to increase that length of vehicle life to be at least 7½ years, which will be a very considerable saving in itself.

Another company was faced with the purchasing of a large amount of equipment and it endeavored to build its own motor-vehicles, about 50 motor-trucks, purchasing the needed units for assembling them. At that point we analyzed very carefully the total expenditure and compared the cost of those vehicles with the cost of modern uptodate equipment already built. The first surprising thing we found was that the cost of building those vehicles was approximately the same for which they could be bought already built, because a certain profit had to go to each one of the unit-part makers. It was self-evident, after a study, that it was the poorest possible economy to step into the manufacturer's field with no more information and experience than a very casual and incomplete investigation, and the plan was abandoned. The material that the company had on hand was salvaged. The few experimental models which the company built ran successfully for a matter of a year before the new program was launched, but have since given a considerable amount of trouble. They had no manufacturer back of them, some of the parts makers have since gone out of business, and some of the individual parts that the company bought were found later to have been superseded by later types. In problems of that kind, I feel that a person with experience in the manufacturing end can go to the user and can save him considerable trouble and expense. I desire to urge a spirit of open-mindedness in reference to consultant service.

FACTORS OF MOTOR-VEHICLE COORDINATION

J. K. MCNEILLIE[9]:—I have taken the stand consistently throughout my connection with the problem of motor-vehicle transportation that the internal-combustion engine has its place in the transportation scheme. During the last 5 years the growth has been very marked, which condition, incidentally, must be satisfactory to the industry itself. In my opinion the industry is one or two jumps ahead of other factors which have an important bearing on the situation as leading up to that ideal state of coordination which we have heard discussed so much during this meeting.

Three factors seem to me well worthy of consideration. I shall call the first, "radiation." By that I mean the system of highways over which this tremendous and growing fleet of motor-vehicles must operate. The railroads have met, are meeting and will continue to meet with very keen competition from motor-vehicles moving over highways. To the cost of the construction and the maintenance of these highways the railroads contribute very materially through the medium of taxation. A properly developed system of highways is as important

[6] Assistant engineer, bureau of economics, Canadian National Railway, Montreal, Canada.

[7] See United States Reports, vol. 251, p. 123.

[8] Consulting engineer, Waltham, Mass.

[9] Superintendent, Delaware & Hudson Railroad Co., Albany, N. Y.

to the industry as it is to the railroads. However, during the extensive highway-development, have representatives of the automotive industry been consulted as to where to locate new highways, or as to what highways of an existing system should be hard-surfaced or improved? Political considerations seem to predominate and the users of these avenues of transportation have not been consulted, so far as I know, as to how the money should be spent. If the industry is to continue to develop and if we are to have the coordination we are all looking forward to, the economically proper location of highways is a vital factor.

The second factor is "organization." In my experience there has been a conspicuous lack of properly organized motor-vehicle companies, financially strong enough to take over the carrying of certain classes of persons and property. I refer to that type of short-haul transportation which is being carried by the railroads at a loss and which I think in the last analysis the railroads will be glad to be rid of, if at the same time they can be relieved of a reasonable part of the cost of transporting that unprofitable class of traffic.

For example, a case typical of many localities in this Country is that of a certain junction point not more than 300 miles from Boston where occurrences like the following take place twice or more every day. A main-line passenger-train reaches a junction-point carrying passengers, express, mail, and baggage. The number of passengers for transfer has become so small within the last few years they are hardly worth considering, but the express, the mail and the baggage must be handled. The branch-line train that connects with the main-line train has a run of about 14 miles, but the greatest part of its work is within 5 miles of the junction-point, where a city, an important manufacturing-center, is located. To handle the mail, the express and the baggage, the services of employes in the baggage car on the main-line train and the services of porters at the station are required. The commodities are unloaded from the main-line baggage-cars onto station trucks, moved 150 ft. to the branch-line baggage-car, loaded into this car and sorted there in readiness to be dropped off at their destination. After all this work is done, occupying say 30 min., the branch-line train moves 5 miles. Then these commodities are handled again, being removed from the baggage car and loaded onto motor-trucks, which transport them to their destination in the city referred to.

To illustrate the absurdity of this procedure, paralleling this steam-railroad is a hard-surfaced highway. Motor-trucks which transport the commodities from the branch-line train to their destination in the city readily could travel to the junction-point in the time they consume in awaiting the branch-line train, load the commodities directly from the main-line baggage-cars and deliver them at their destination in the city before the branch-line-train operation could be completed. Although that situation has existed for years and has been noticeable during this period of increased motor-vehicle transportation, no motor-vehicle operator, to my knowledge, and there are many of them in that territory, has gone to the railroad officials and made a proposition to them to take this business and handle it, although the operator could make a profit and the railroad handles the traffic at a loss.

The third factor is "legislation." There is lack of authority on the part of legislators to regulate motor-coach and freight traffic. For example, the report of the New York State Public Service Commission for 1925 mentions its inability to regulate this matter in a comprehensive manner. Further, that it has no control whatever over freight traffic. Until we get proper radiation, proper organization and adequate legislation, much remains to be done.

Has the Motor-Truck Arrived?

B. F. Fitch[10]:—I believe we are facing new aspects of a very old subject. The peculiar thing about our national transportation system is that, except for industrial siding and team-track carload freight, all the freight handled by the railroads is trucked. Formerly, it was hauled by horse-drawn vehicles. The mileage limitations of the horse are thus responsible for the industrial layout of every city in the United States. Now, the motor-truck appears and its limitation from an economic standpoint is standing-time instead of, as with the horse, mileage; hence, the entire situation is reversed. In other words, does the existing terminal layout of plant conform with this new motor-vehicle type of terminal transportation and does not this new motor-vehicle type of transportation make possible a complete revision of terminal plant through the simple procedure of turning it inside out by locating railroad terminals in the outskirts of a city, at the felloe of the wheel, so to speak, and running motor-vehicles from such terminals along the spokes to the hub, instead of having the terminal stations at the hub as at present?

Has the motor-truck arrived? I have read with great interest testimony by railroad officials in a recent hearing of the Interstate Commerce Commission. Without a single exception, all its members claim that the railroads are losing money by reason of the competition of the motor-vehicle. During the last 10 years, every railroad official to whom I have talked has claimed that short-haul, less-than-carload traffic is handled at a loss. Is it not significant that the railroads claim they are losing a business which created a loss, while at the same time railroad earnings in 1926 are showing the greatest increase in the history of the Country?

Perhaps the motor-truck, even as utilized at present, has arrived, but its arrival is not recognized. There is no standardization of usage, and there is as yet no recognized coordination. My conception of the coordination of the motor-truck with the railroads is the proper allotment of each one of the existing transportation facilities to the zone in which it can function at greatest efficiency. Possibly the increased radius of motor-truck operation is actually decreasing the previous less-than-carload losses of the railroads, as reflected in their earnings for 1926.

[10] President, Motor Terminals Co., New York City.

Reports of Society Committees

AT the Semi-Annual Business Meeting which was held on Wednesday evening, May 25, reports were submitted by the chairmen of the Meetings, Membership, Publication, Research, Sections, and Standards Committees and by Treasurer C. B. Whittelsey covering the Society's activities during the first 4 months of the administrative year. Copies of these reports were distributed in booklet form to the members present. Among the more interesting points brought out in these reports are

The membership of the Society, including Affiliate Members and Enrolled Students, is 6245 or an increase of 396 over last year.

The total membership of the Section is 3085, or an increase of 342 over last year.

National and Sections meetings held since the first of the year totalled 59, and 120 papers were presented. Seventy-two papers and discussions were published in THE JOURNAL.

The Employment Service has placed 162 members in desirable positions in the last year.

The income of the Society shows an increase for the first 7 months of the fiscal year of approximately $25,000 over the same period of last year.

The March, 1927, issue of the S.A.E. HANDBOOK contains as a new feature a listing of approximately 600 manufacturers of parts and materials made in accordance with S.A.E. Standards.

The Production Advisory and the Operation and Maintenance Committees have developed active programs during the year. Departments in THE JOURNAL have been instituted for each of these groups.

The committee reports are given substantially in full hereinafter.

MEETINGS COMMITTEE REPORT

At the January meeting of the Committee plans were made definitely to hold the following National meetings during the administration year of 1927:

May 25 to 28	Summer Meeting	French Lick Springs
Sept. 19 to 20	Production Meeting	Cleveland
Sept. 21 to 22		Detroit
November	Transportation Meeting	Chicago
Dec. 1	Tractor Meeting	Chicago
Jan. 12, 1928	Annual Dinner	New York City
Jan. 24 to 27	Annual Meeting	Detroit

It was also definitely agreed to hold an Aeronautic Meeting at the time and place of the National Air Races, the date of which has not been set at this time, and a Motorboat Meeting.

JOINT PETROLEUM MEETING

The Meetings Committee has accepted the invitation of the American Chemical Society to hold a joint meeting in September at which petroleum matters will be discussed. The Committee is cooperating with the Research Committee in planning the part of the program for which the Meetings Committee will be responsible.

VISIT TO ABERDEEN PROVING GROUND

The Meetings Committee has also accepted the invitation of the Army Ordnance Association to meet with it at the Ninth Annual Meeting at the Aberdeen Proving Ground on Oct. 6. The Committee has suggested that the various Sections hold special meetings on the day preceding the visit to the Proving Ground at which automotive ordnance subjects might be discussed. Several of the Sections have indicated that they will do this.

THE SUMMER MEETING

The decision to hold the Summer Meeting again at French Lick Springs was reached only after very careful consideration by the Council, the Sections Committee and the Meetings Committee. Conditions were such, however, that it was generally agreed that French Lick Springs was the most desirable location for this meeting. Inasmuch as the Summer Meeting has now been held 2 years in succession at a Western location, it appears advisable that the 1928 Summer Meeting be held in the Eastern part of the Country and inasmuch as it is necessary to make hotel reservations at least 6 months in advance, the Meetings Committee will give careful consideration to the location for the 1928 Summer Meeting and will report its findings to the Council.

The Meetings Committee has been very fortunate in the program for the Summer Meeting, both from the standpoint of engineering matters and entertainment and sports events. The technical program is well on a par with the programs of other National meetings of the Society, the interesting program of sports and entertainments also being maintained at past standards. It is to be regretted that an impression prevails in some parts of the industry that the Summer Meeting puts more emphasis on sports and entertainment activities than on technical features of the program. The comprehensive technical program arranged for the 1927 Summer Meeting should be sufficient evidence that this phase of the meeting is emphasized.

THE PRODUCTION MEETING

Owing to the vital interest of the Production Advisory Committee in the Production Meeting, the Subcommittee appointed to plan the program for the Production Meeting has included in its personnel the membership of the Production Advisory Committee, the Subcommittee acting under the chairmanship of John Younger. Owing to the fact that the American Society for Steel Treating and the American Machine Tool Builders Association are holding simultaneous meetings in Cleveland and Detroit respectively during the week of Sept. 19, the Meetings Committee felt it advisable to hold a 4-day Production Meeting, the first 2 days being in Cleveland and the last 2 in Detroit, arrangements being made for transportation from Cleveland to Detroit by boat.

THE TRANSPORTATION MEETING

Under the chairmanship of Paul Weeks, a Subcommittee will be appointed to plan the program for the Transportation Meeting that will be held in Chicago early in November. As in the case of the Production Meeting Subcommittee and the Production Advisory Committee, the personnel of the Subcommittee in charge of the Transportation Meeting will be drawn largely from the Operation and Maintenance Committee.

THE TRACTOR MEETING

This year the Tractor Meeting has been scheduled for Dec. 1 in Chicago, this meeting immediately following the 2-day meeting of the American Society for Agricultural Engineers. It will consequently be possible for the members of the Society interested in tractor engineering to attend the sessions of the American Society of Agricultural Engineers and for the members of the American Society of Agricultural Engineers to attend the S.A.E. Tractor Meeting sessions.

THE ANNUAL DINNER

It is expected that satisfactory arrangements will again be made for holding the Annual Dinner at the Hotel Astor, New York City, on the night of Jan. 12. No definite plans have been made for the dinner.

The Annual Meeting

The 1928 Annual Meeting will be held in Detroit during the week preceding the Chicago Automobile Show. Several papers are now being prepared for the technical sessions and an excellent program seems assured.

Technical Papers

In planning the subjects to be discussed at the technical sessions at National meetings, the Meetings Committee is governed very largely by suggestions received from members of the Society in the form of answers to questionnaires, by comment on definite suggestions and by personal contact with leading engineers. It should be clearly understood that the Committee welcomes all suggestions as to subjects and to possible authors. It is only through the splendid cooperation of the members in this work that the Meetings Committee has been so fortunate in the past in planning technical sessions that warrant the time and expense of the members of the Society in attending the National meetings.

L. C. Hill,
Chairman, Meetings Committee.

MEMBERSHIP COMMITTEE REPORT

With the continued support and cooperation that the members of the Society and Officers of the Sections have given the Membership Committee there has been an increase in the membership of the Society of approximately 7 per cent during the last year, or a 1 per cent greater gain than for the same period for the year previous.

The membership booklet and letters have been recently revised with an attempt to approach the prospective member with material that will actively arouse his interest in the Society. This literature has been in use a little over a month and the returns are very gratifying.

The following table indicates very clearly the trend of membership for the last 3 years up to May 1, 1927. During the last year the rate of applications received per month has fallen off, but the percentage of those qualifying by payment of dues has been much higher. Members dropped, resigned and deceased average 43 per month as compared with 38 per month for the previous year. At the present time there are only 374 members who are delinquent in dues against a figure of 539 for the previous year. As of May 1 there were 214 applications awaiting action by the Grading Committee and the Council.

MEMBERS QUALIFIED BY PAYMENT OF INITIATION FEE AND DUES

	1924-1925	1925-1926	1926-1927
May	12	74	75
June	71	39	123
July	95	92	59
August	47	39	79
September	10	18	50
October	58	33	60
November	54	106	71
December	56	76	23
January	81	84	89
February	69	54	55
March	45	91	33
April	56	59	57
	654	765	774

The following figures give the membership by grades for April 30, 1926 and 1927.

	1926	1927
Members	2,834	2,952
Associates	1,781	1,932
Juniors	486	527
Foreign Members	116	141
Service Members	95	96
Affiliates	109	110
	5,421	5,758
Affiliate Representatives	195	192
Enrolled Students	233	295
Total	5,849	6,245

It will be noted that there is an increase in all grades of membership over the figures for the previous year.

F. K. Glynn,
Chairman, Membership Committee.

PUBLICATION COMMITTEE REPORT

Some idea of the growth of the Society's publication work for the first 5 months of the current year as compared with the corresponding period of 1926 is reflected in the accompanying table. As the present volume marks the completion of the 10th year of the publication of The Journal, similar figures for the first 5 months of 1918 are included to indicate the progress made in that time.

COMPARATIVE DATA ON SIZE OF AND MATERIAL INCLUDED IN THE JOURNAL FOR THE FIRST 5 MONTHS OF 1918, 1926 AND 1927

	1927	1926	1918
Total Pages	1,384	1,191	940
Text Pages	739¼	567	398⅞
National Meetings Papers Published	35	25	15
Sections Meetings Papers Published	20	17	23
Discussions Published Separately	17	17	1
Contributed Articles Published	3	2	5

The policy of printing papers and discussions as promptly as possible after their presentation has been continued, the average elapsed time between the presentation of papers or discussions printed in the first 5 issues of The Journal for this year and publication being 4.6 months, as compared with 3.3 months for the corresponding period of 1926.

In the May issue of The Journal, two new departments, Operation and Maintenance, and Production Engineering, were inaugurated. The former is intended to bring together as much as possible in The Journal items that are of particular interest to the members who are engaged in the operation and maintenance of motor-vehicle fleets and will include references to the work of the Operation and Maintenance Committee of the Society and other activities in this field of the automotive industry. The Production Engineering Department will serve a similar purpose for the production engineer. Among the subjects that it is planned to cover are the activities of the Production Division of the Standards Committee, the Production Advisory Committee and other general Committees of the Society relating to production topics.

The printing of illustrated news stories of Society and Sections meetings held the previous month has been continued. Plans are being considered to increase the attractiveness of these stories as well as the pages of The Journal in general.

No part of Transactions has been issued in the period covered by this report, but Part II of the 1925 Transactions will, it is expected, be mailed in the near future. This volume will contain 43 papers and consist of approximately 928 pp. Work will be begun on Part I of the 1926 Transactions in the near future and the volume should, barring any unforeseen delays, be mailed during the fall. It will contain 26 papers.

Since Jan. 1, 1927, 11 reprints have been furnished to authors and interested organizations.

Edward P. Warner,
Chairman, Publication Committee.

RESEARCH COMMITTEE REPORT

In recognition of the importance of operation and maintenance and of production in the field of automotive engineering, the Research Committee during the last year added members representing these activities to its personnel. The membership of the committee has also been further enlarged with a consequent widening of interests. The organization of

its subcommittees has been simplified with a view to the more efficient handling of the various research projects under its jurisdiction.

While the Research Committee maintains a general supervision over the research policy and projects of the Society, it functions mainly through its subcommittees and through the Research Department. The report will deal with each of these individually.

Fuels Research

The present Fuels Subcommittee is a consolidation of Division 1, Economic Aspects, and Division 2, Specifications, of the 1926 Fuels Subcommittees and of the former Lubricants Subcommittee, and embraces in its functions the activities of the three groups.

The members of the Fuels Subcommittee represent the Society on the Cooperative Fuel-Research Steering Committee, which directs the joint investigation being carried out at the Bureau of Standards under the auspices of the National Automobile Chamber of Commerce, the American Petroleum Institute and this Society.

One of the problems with which the Cooperative Fuel-Research Steering Committee has been concerned for the last 6 months has been the study of engine acceleration. In this study, an engine of modern passenger-car design has been used and the work done thus far gives some information as to the relative influence of speed range, carbureter characteristics, jacket-water temperature, intake-manifold temperature, carbureter adjustment and the injection of an accelerating charge upon the acceleration performance of a given engine using a common fuel. A report of this project will be given by J. O. Eisinger at the Research Session at the Summer Meeting. These are preliminary to the next step in this research, which is a study of the acceleration performance obtainable with different fuels under a variety of temperature conditions.

Another topic of study during the last 6 months has been the determination of the average antiknock characteristics of present-day motor fuels. The object of the investigation is to furnish the automotive engineer with information that will be of assistance to him in regulating compression ratios. In carrying out this project a preliminary survey was first made, in which 16 samples of representative fuels were collected and their antiknock characteristics determined. From the results of this survey an idea can be obtained as to the range of the antiknock qualities of available fuels. A second survey was then made directed more exactly at determining the average antidetonating characteristics of all the gasoline produced. Compound samples were collected for each of a number of territories throughout the Country. These samples were made up of gasoline sold in each district, the amount of any particular gasoline included in the sample depending on the bulk of its sales as revealed by the State tax figures, where these were obtainable. The antiknocking characteristics of the resulting compound samples were then determined. The detonation study is still in progress.

Another subject before the Cooperative Fuel Research Steering Committee during the last 6 months was the cooling rate of automobiles left exposed to the weather. Attention is being given to putting into simple and easily understood form the results obtained so that they may be more widely read and applied.

The Fuels Subcommittee includes in its functions those of the former Division 2, which dealt with specifications in cooperation with the American Society for Testing Materials and the Bureau of Standards. As part of its activities in this connection the Fuels Committee has given consideration to the desirability of undertaking the standardizing of specifications for engine distillate and of drawing up specifications and testing methods for lubricating oil usage. Both of these subjects have been the subject of frequent inquiry, the National Automobile Dealers Association, among others, having shown especial interest in the latter. The opinions of the Fuels Subcommittee were sought with the idea that they might serve as a guide to the Standards Committee in further consideration of this subject.

Headlighting

The Headlighting Subcommittee represents the Society on the Joint Steering Committee on Headlighting Research, which directs the investigation into headlighting being carried out by the Illuminating Engineering Society and this Society. The main efforts of the Subcommittee have been directed toward bringing more participants actively into this research and assisting those already enlisted in carrying out their studies.

Additional interest in the test equipment, which was developed for independent investigators, has been shown and further orders for it from car and head-lamp manufacturers and universities are definitely in prospect.

Members of the subcommittee have also devoted much time, thought and experimental work to the development of a test program which will serve as a guide for the purchasers of the test equipment. The program will include a description of a set of experiments to be made, and instructions for making them and recording results. The object of these tests will be to elicit the opinion of the investigators on certain unsettled questions concerning headlighting performance, such as the desirable depth or width of beam, how wide the high intensity beam should be at the top as compared with the whole, and similar questions. Since the tests will be alike and performed as nearly as possible under certain prescribed conditions, the results obtained can be compared and form the basis of discussion. A meeting of the Headlighting Subcommittee, together with purchasers of the test equipment and others interested, will be held during the Summer Meeting, at which time the proposed program will be discussed. At night, demonstrations of the possibilities of the test equipment and some of the results obtained with it will be shown.

The headlighting investigation being carried out at the Bureau of Standards seems a proper topic for mention here. This study is to be conducted at the Bureau of Standards under the technical direction of the Research Committee and under the supervision of its Chairman. Its object is to determine what actual road conditions are to be met and what state present-day apparatus is in.

Riding Qualities

Members of the Riding Qualities Subcommittee, acting individually and in cooperation with other members, have continued their studies in this field. An interesting project now being put into execution is the determination of the susceptibility of the average person to vibrations of various amplitudes and periods. Prof. E. H. Lockwood, member of the Riding Qualities Subcommittee, and L. C. Lichty, both of Yale University, will carry out this investigation, using for the purpose a vibrating chair similar to that developed at the Bureau of Standards, but with some modifications indicated as advisable by previous tests with it. Since, in the last analysis, the sovereign criterion for riding qualities consists of the sensations and reactions of the rider, the proposed study is important and fundamental.

Highways

One of the activities of the Society in the field of highway research is its participation, together with the Bureau of Public Roads and the Rubber Association of America, in the cooperative study of motor-truck impacts. Topics that have been considered and discussed in this project are the testing of cushion wheels and the correlation of the static and impact tests of tires.

The Research Committee, through its Chairman, has also maintained contact with the activities of the Executive Committee of the Highway Research Board, on which he is the Society representative. One phase of the work of the Highway Research Board has been of especial interest, the proposal to study the causes and possible means of preventing highway accidents. While this investigation will be made from the point-of-view of highway design and composition, it will undoubtedly develop material of interest to automotive engineers, and its progress is being closely watched.

Research Department

In addition to assisting in executing the plans formed by the Research Committee and its subcommittees, the Research Department performs certain independent functions. Chief of these, toward which much of its effort is directed, is acting as a clearing house for technical information.

One method of disseminating technical information is through the columns of The Journal. The Research Department endeavors to obtain for the Automotive Research Department from active research workers reports on the projects on which they are engaged. Summaries of developments are also included in this department.

With the purpose of making the information service as accurate and as complete as possible, about 75 technical and trade publications are indexed, informative pamphlets are collected and filed and books in the automotive and allied fields are added to the Society library. To enable it to act more efficiently as a clearing house for research data, the Research Department is also making every effort to keep in touch with the research activities in colleges and universities and in industry and has had a gratifying response from the institutions already approached. A systematic canvass of technical institutions of learning is now being made with the object of obtaining data on their past and present research work and their research facilities both of personnel and of equipment. In connection with this phase of its work the Research Department is indebted to Dean A. A. Potter and Prof. G. A. Young of Purdue University for the paper on Research in Engineering Colleges presented by them at the 1927 Annual Meeting and for that on Research in Industry to be presented by W. S. James at the Summer Meeting.

H. C. Dickinson,
Chairman, Research Committee.

SECTIONS COMMITTEE REPORT

Since the beginning of the administrative year the Sections of the Society have held 51 meetings at which 53 papers were presented.

Section Membership

At the January meeting of the Sections Committee it was decided that the membership of the Sections should be figured on a percentage basis, the percentage standing of any one Section to be the number of Society members in the Section territory that were members of the Section. Since the January meeting the committee has designated the territory for each Section by counties. The Section territories have been approved by the Sections and the Section membership figures compiled, the standing of the different Sections on this basis as of May 1 being as follows:

Section	Actual Number of Society Members in Territory	Number of Section Members	Percentage of Section Members to Society Members
Buffalo	82	111	135.4
New England	118	125	105.9
Indiana	102	108	105.9
Pennsylvania	221	218	98.6
Detroit	942	780	82.8
Metropolitan	1,005	801	79.7
Milwaukee	121	95	78.5
Southern California	109	84	77.1
Chicago	389	292	75.1
Cleveland	358	267	74.6
Northern California	130	85	65.4
Washington	97	62	63.9
Dayton	140	61	43.5
	3,814	3,089	81.0

The actual standing of the Sections on May 1 is given in the following table, the total membership and the increase in percentage of the total membership being given. It will be noted that the Northern and Southern California Sections have the honor of showing the greatest increase in membership, although the Metropolitan Section, as a result of its exceptionally fine membership campaign, increased its membership from 620 to 801 or practically 30 per cent, passing Detroit in total membership.

Section	1926	1927	Increase, Per Cent
Northern California	53	85	60.1
Southern California	59	84	42.3
Metropolitan	620	801	29.2
Buffalo	90	111	23.3
Chicago	263	292	10.0
Indiana	100	108	8.0
Milwaukee	89	95	6.7
Detroit	743	780	5.0
Pennsylvania	209	218	4.3
Cleveland	258	267	3.5
Washington	60	62	3.3
New England	127	125	1.6[a]
Dayton	66	61	7.6[a]
Total Section Membership	2,742	3,089	12.1
Total Society Membership	5,616	5,950	6.0

[a] Decrease.

To aid the Sections in increasing their membership, the Membership Committee has suggested that all Sections register members and guests at their meetings, the registration cards being sent to the Society with the stenotype reports of the meetings. These cards serve a dual purpose in that they permit the names in The Journal accounts to be verified and the Membership Committee can follow up all non-members for Society Membership. This will work to the advantage of the Sections as a large percentage of the members joining the Society also join the Sections.

Proposed New Sections

Since the January meeting the organization of Sections in Denver, Flint and Pittsburgh has been proposed. As the Society membership in Denver was not sufficient to warrant the organization of a Section, an unofficial group known as the S. A. E. Club of Colorado was organized with a membership of 16, under the chairmanship of E. T. Harrison, Vernon Peterson being secretary. Monthly meetings have been held since the Automobile Show in February.

The Sections Committee will act shortly on the desirability of eventually establishing Sections in Flint and in Pittsburgh.

Student Groups

Since the January meeting the charters for the Student Branches at the Ohio State University and the Massachusetts Institute of Technology have been approved by the Council. Both groups are very active, hold monthly meetings and are cooperating with the local Sections of the Society.

Under the sponsorship of the Metropolitan Section, a Student Conference was held in New York City on Feb. 16. The papers presented at this meeting by President J. H. Hunt, David Beecroft, John Younger, and R. E. Plimpton covering the fields for engineering students in the automotive industry will be printed in pamphlet form for distribution among students interested in the work of the Society.

As an indication of the close cooperation between the Sections and the Student Branches, it is interesting to note that the Ohio State University Student Branch acted as host for the Cleveland Section on May 14, and the Indiana Section held a meeting at Purdue University on May 12.

F. F. Chandler, Chairman, Sections Committee.

STANDARDS COMMITTEE REPORT

The 1927 Standards Committee comprises 22 Divisions with the approximate total of 250 members. The Chain Division was discontinued inasmuch as its activities heretofore related mostly to the roller type of chains which is used to a limited extent. Large quantities of these chains are used, however, in other mechanical industries and standardization is being carried forward by a Sectional Committee sponsored by the American Society of Mechanical Engineers, the American Gear Manufacturers Association and the Society under the procedure of the American Engineering Standards Com-

mittee. Revisions of present standards or new standards for roller chains as they are referred to the Society, will be considered by the Motor Truck Division while matters concerning the silent type of chain will be assigned to the Engine Division. The work of the Passenger-Car Body Division has been consolidated with the Passenger Car Division and that of the Storage-Battery Division transferred to the Electrical Equipment Division.

Meetings

Due to the exceptionally short time between the Annual Meeting last January and the Semi-Annual Meeting, relatively few meetings of the Divisions and the Subdivisions have been held in the course of preparing reports for the May meeting of the Standards Committee.

Production Division

The Production Division reported in January the first production standard adopted by the Society. This is the report on T-Slots, Bolts, Nuts, Tongues and Cutters, for planing machine tables and similar machine-tools. It was decided to publish the production standards adopted by the Society on 8½ x 11-in. loose-leaf sheets for standard three-ring binders inasmuch as this form would be more useful to the production engineers than to incorporate these standards in a section of the present S.A.E. Handbook.

S.A.E. Handbook

The third edition of the bound S.A.E. Handbook was issued in March, the principal change from the previous issues being the inclusion of the classified list of approximately 600 manufacturers who have certified that the products under which they are classified are in accordance with S.A.E. Specifications. The general index was brought into the text section, together with the Standards Committee Personnel, Standards Committee Regulations and references to American Standards.

Operation and Maintenance Committee

The Committee on Operation and Maintenance was organized this year as a general Society committee to represent the interests of the motor-vehicle fleet operators. Subcommittees are studying the possibility of formulating a standardized classification of account titles for fleet operation and maintenance, the defining of terms used in such a classification and in developing uniform mechanical information sheets for use in connection with the maintenance of vehicles. A Subcommittee is also studying the relation of State and municipal regulations to fleet operation and maintenance. Members of the Committee have also been designated to work with the Meetings, Membership, Publication, Research, and Sections Committees of the Society. Standardization matters will be referred to the Motorcoach and Motor-Truck Divisions of the Standards Committee.

Production Advisory Committee

The Production Advisory Committee was organized this year to represent the production engineering interests of the Society. Its principal activities so far have been in connection with the plans for the Annual Production Meeting of the Society in September, in planning for greater activity of the production men in the Sections and in securing production papers for meetings and publication in The Journal.

National Standardization

A survey of standardization activities in all fields of industry in the United States was made early this year by a committee of which Secretary of Commerce Herbert Hoover was chairman. This committee found that in general, standardization suffers greatly because of lack of interest and support by industrial executives and suggested a plan for organizing and financing a national industrial standardization board or organization of executives, but no definite course of action in this connection has been determined upon.

International Standardization

For the last 2 years or so the developing of a definite international organization for the advancement of international standardization has been under consideration in America and the principal foreign countries, the Society taking an interest in this as a member body of the American Engineering Standards Committee. About a year ago a suggested constitution for such a body was discussed at an international conference of Secretaries of foreign national standardizing bodies held in New York City. Further action in this connection was considered at a limited conference in London last September at which the matter was deferred for a year for further consideration. Since then plans have been put forward in the United States for organizing an American body through which international standardization activities would be conducted. The Society has been studying this movement in order to maintain the interests of the automotive industry in whatever is done.

K. S. Herrmann, Chairman, Standards Committee.

TREASURER'S REPORT

The table printed below and those on p. 780 compare the financial condition of the Society for the first 7 months of the fiscal year with the corresponding period for 1926.

TREASURER'S REPORT

	1926	1927
Budget Income	$192,791.67	$220,733.34
Actual Income	198,506.90	222,900.86
Gross Income over Budget	5,715.23	2,167.52
Budget Expense	192,791.67	213,441.67
Actual Expense	199,423.51	203,266.20
Unexpended Income	916.61[a]	19,634.66
Cash	18,366.60	33,337.60
Accounts Receivable	21,459.34	17,490.18
Accounts Payable	11,730.18	1,424.46
Balance of Assets over Liabilities	152,069.16	194,435.81
Securities Deposited with the Chemical National Bank of New York, Book Value	154,998.63	185,279.82
Market Value April 2, 1927		191,564.54

[a] Deficit.

COMPARATIVE BALANCE SHEET AS OF APRIL 30, 1927, AND APRIL 30, 1926

Assets	1927	1926	Increase	Decrease
Cash	$33,337.60	$18,366.60	$14,971.00	......
Accounts Receivable	17,490.18	21,459.34	......	$3,969.16
Securities	185,279.82	154,998.63	30,281.19	......
Accrued Interest on Securities	2,060.71	1,563.37	497.34	......
Inventories	1,201.60	1,403.90	......	202.30
Furniture and Fixtures	2,419.86	4,840.24	......	2,420.38
Items Paid in Advance, Charges Deferred	8,139.56	8,214.76	......	75.20
TOTAL ASSETS	$249,929.33	$210,846.84	$39,082.49	......
Liabilities and Reserves				
Accounts Payable	$262.50	$8,848.04	......	$8,585.54
Accrued Commission	1,161.96	2,882.14	......	1,720.18
Dues and Miscellaneous Items Received in Advance	38,664.40	35,967.62	$2,696.78	......
Reserves Set Aside for Anticipated Expenses	15,404.66	11,079.88	4,324.78	......
General Reserve	174,801.15	152,985.77	21,815.38	......
Net Unexpended Income	19,634.66	916.61[b]	20,551.27	......
TOTAL LIABILITIES AND RESERVES	$249,929.33	$210,846.84	$39,082.49	......

[b] Deficit.

INCOME AND EXPENSE COMPARISON FOR 7 MONTHS, OCT. 1, 1925, TO APRIL 30, 1926, AND OCT. 1, 1926, TO APRIL 30, 1927

		7 Months Oct. 1, to April 30,			
Income	April	1926-1927	1925-1926	Increase	Decrease
Dues and Subscriptions	$6,959.16	$48,236.66	$46,387.80	$1,848.86	......
Affiliated Appropriations	625.00	4,375.00	4,375.00	......	......
Interest	783.87	5,347.87	4,008.25	1,339.62	......
Initiation Fees	1,475.00	11,690.00	10,020.00	1,670.00	......
Advertising Sales—Journal	16,954.00	129,743.00	120,493.00	9,250.00	......
Advertising Sales—Handbook	......	8,850.00	......	8,850.00	......
Miscellaneous Sales	2,228.35	14,658.33	13,222.85	1,435.48	......
TOTAL INCOME	$29,025.38	$222,900.86	$198,506.90	$24,393.96	......
Expense					
Publications	$6,173.05	$47,327.09	$40,440.90	$6,886.19	......
Sections	958.37	7,431.20	7,999.44	......	568.24
Research	1,370.45	8,343.41	10,594.84	......	2,251.43
Employment Service	338.54	2,008.76	2,418.83	......	410.07
Standards	2,004.78	12,628.14	11,105.68	1,522.46	......
Meetings—Net Cost[1]	1,125.02	16,025.32	17,135.71	......	1,110.39
Cost of Membership Increase	1,287.47	6,638.61	7,973.57	......	1,334.96
Cost of Advertising Sales—Journal	5,367.01	37,345.09	42,370.57	......	5,025.48
Cost of Advertising Sales—Handbook	......	1,428.11	......	1,428.11	......
Cost of Miscellaneous Sales	1,086.50	9,095.14	10,103.57	......	1,008.43
Operation and Maintenance Committee	65.91	76.50	......	76.50	......
Production Advisory Committee	.41	72.22	......	72.22	......
General Expense	8,537.21	54,846.61	49,280.40	5,566.21	......
TOTAL EXPENSE	$28,314.72	$203,266.20	$199,423.51	$3,842.69	......
Net Unexpended Income	$710.66	$19,634.66	$916.61[c]	$20,551.27	......

[1] Ticket sales and other receipts deducted.
[c] Deficit.

The books of account were audited by Haskins & Sells as of March 31, 1927, and their report is very favorable.

C. B. WHITTELSEY,
Treasurer.

ACTIVITIES OF THE SECTIONS

News accounts of Sections meetings that were held during the preceding month, as well as announcements of forthcoming meetings, are presented in this department

DEVELOPMENT OF WORM-GEAR BRONZES

Buffalo Hears of Recent Improvements in Alloys and Methods of Casting

At the meeting of the Buffalo Section, held at Hotel Statler on May 3, Chairman William R. Gordon introduced Thomas W. H. Jeacock, president of the Buffalo Bronze Die Cast Corporation, who presented a paper on worm-gear bronzes. In his paper Mr. Jeacock said that worm-drives, formerly used only on trucks and motorcoaches, are now being adopted for passenger-cars because of the demand for lower center of gravity and over-all height, but that the change will come slowly because it is radical.

When introduced from England worm-gear blanks were heavy sand castings containing 89 per cent of copper and 11 per cent of tin. Requirements of lighter weight and higher unit pressure have been met by improving the bronze, first by chilling the face of the blank and later by chilling the face and both sides, thus producing finer grain in almost the entire blank. Casting in chills eliminates all machining operations on the face and sides of the blanks and saves the weight of metal that would be allowed for finish.

Improvement has also been made in the alloy by the introduction of nickel, the proportions now largely used being 89 per cent of copper, 10 per cent of tin and 1 per cent of nickel. These improvements result in a yield point of nearly 50,000 lb. with 7-per cent elongation, while a yield point of 24,000 lb. with 4 to 4½-per cent elongation was considered satisfactory a few years ago. It is also said that pitting is reduced, wearing quality bettered and operating temperature reduced. Still better quality can be produced by the centrifugal casting-process, but the cost is somewhat higher than casting in fixed chills.

Aluminum bronze is found suitable only for comparatively low pressures and speeds. It is used in the Ford 1-ton truck but not in the Fordson tractor, and other users have had difficulty with the metal cutting under heavy load.

Development of Die-Casting

When the largest die-casting being made by Mr. Jeacock's firm weighed 1 lb. it began experimenting with die-castings to replace the 15-lb. sand castings for the Ford truck. Later the company made large quantities of these blanks with the teeth cast in, 1/16 in. being allowed for hobbing finish. The alloy used was 90 per cent of copper and 10 per cent of aluminum. This is both lighter and less expensive than the tin alloy. Die-casting saved 4 lb. of bronze in each blank, and hobbing time was cut from 12 to less than 2 min.

Tests on a number of alloys at a temperature of 550 deg. fahr. showed the strength at this temperature to be the same as at room temperature.

During the discussion Mr. Jeacock gave further information, chiefly in reply to questions. Iridium-bronze worm-gears are said to be suitable for high unit pressure but not for high speed. High Brinell test can be obtained by increasing tin or phosphorus content but does not necessarily mean good wearing qualities. Aluminum bronze is strong and light, with high Brinell test, but does not wear well unless conditions are favorable. If particles are pulled away from the surface they break off and become powder, while in a gear bronze they are rolled back into the surface of the tooth. Use of aluminum bronze for passenger-car worm-gears would be desirable because of lighter weight and lower cost, but it will not stand the service with the pressures imposed by the small gear-diameters. The addition of 2 per cent of lead to the alloy improves the service but makes a blank that is very hard to machine.

Lubrication Discussed

M. L. Weir of the Vacuum Oil Co., reported difficulty in recommending the proper oil for worm-gear drives in passenger-cars because of temperature variations, citing 20 to 30 deg. below zero at Winnipeg. He also asked if the use of bronze in place of steel would eliminate lubrication trouble with hypoid-gears. Attention was called to the fact that the hypoid-gear is intermediate between a bevel-gear and a worm-gear, and that it has much more sliding contact than the spiral-bevel gear. For this reason it is thought that steel as hard as that used in bevel-gears might not prove satisfactory for hypoid-gears, but Mr. Jeacock expressed no hope that a bronze could be developed strong enough to take the place of the steel for this service.

There was some discussion as to how much a car could be reduced in height by substituting worm for bevel-gears. Where the frame goes over the axle the thickness of the cushion must be reduced to make any gain, and that was criticized as sacrificing comfort. Another speaker noted that at the mid-point of the axle a worm-drive housing is only 5 in. above the axle center, instead of 9 in. as on some bevel-gear axles, and that the floor can be lower without interference with the propeller-shaft if a worm-gear is used. Mr. Jeacock's paper and the discussion will be printed in an early issue of The Journal.

IDEAL HEAD-LAMP AT LAST

Ryan Defines It and Tells Milwaukee Meeting Specifications Have Been Met

A head-lamp that is so far ahead of the times that it will take 5 years for the State motor-vehicle laws to catch up with it was shown in lantern slides and its design and properties described by W. D'Arcy Ryan, director of the Illuminating Engineering Laboratories of the General Electric Co., at the monthly meeting of the Milwaukee Section on May 4 at the Milwaukee Athletic Club. This lamp meets some seemingly impossible specifications in a list of requirements for ideal headlighting as enumerated by Mr. Ryan and, as described, it gives the best sort of road illumination and at the same time minimizes glare in the eyes of approaching drivers.

One hundred members and guests of the Section were greatly interested in and entertained by the address following a members' dinner that was attended by 85. Chairman Walter S. Nathan convened the meeting and, following the balloting, announced the election of officers for the next administrative year of the Section as follows: Chairman, Fred M. Young, Racine Radiator Co.; Vice-Chairman, Walter S. Nathan, Nash Motors Co.; Secretary, Arthur C. Wollensak, Sterling Motor Truck Co.; and Treasurer, George C. Appel, Harley-Davidson Motor Co.

Mr. Young was thereupon invited to take the chair and preside over the rest of the meeting. He announced that for the first meeting of the coming season an outing has been planned for September somewhat like the one in Racine last season but that it is to be held in Milwaukee. In introducing the speaker of the evening, Mr. Young remarked that the members were to hear an illuminating talk by Mr. Ryan, who has been in the service of the General Electric Co. for 35 years, during which period he has

made a deep study of lighting and illumination. Supplementing Mr. Young's statement, it may be stated that Mr. Ryan is the inventor of the Ryan-Lite and is acclaimed a second Steinmetz in the illuminating engineering field. He developed the illuminating project for the Panama-Pacific Exposition at San Francisco and is also noted for his work in connection with illuminating Niagara Falls, his work overseas during the World War and his later work in connection with lighting airways and airdromes.

New Type of Reflector Developed

As typical of the development of the new science of illuminating engineering, to be followed later by the art of illumination, Mr. Ryan recalled a time a generation ago when, as manager of experts of the Southern-Houston Electric Co., he asked for and secured an appropriation of $10,000 to develop a science of the study of light and lighting, and stated that now the company in whose service he is engaged spends $200,000 a year in such studies and in rendering service to all parts of the world. Various kinds of light have been studied and the art of illumination has finally been developed, but automobile headlighting has been left until the last for many reasons. Automotive and illuminating engineers have been struggling with the headlighting problem for quarter of a century, yet, in driving from Albany to Schenectady a few nights before the meeting, the road, said Mr. Ryan, was a blaze of fire notwithstanding the State law for controlling headlights. Certain investigators have declared that headlight glare is not so dangerous as insufficient light on the roadway, but as a matter of fact, declared Mr. Ryan, improperly distributed light on the roadway is one of the greatest causes of accidents and the public is convinced that glare must be suppressed.

On attacking the problem, he first considered the parabolic reflector, which has a short focal-length and is very sensitive to the position to the lamp filament. One of the fundamental difficulties with this type of reflector is that unless very close tolerances are maintained at the factory, large variations in position of the lamp result and very few persons can adjust the mechanism to find the focus point. Another defect is that this reflector gives a disc of light with a strong point in the center called the hot-spot, and if the head-lamp is mounted on the car so that the light is thrown down the road for a good range, the upper fringe of the central rays produce an intolerable glare. If the head-lamp is tilted downward to obviate this glare, the bright spot projected on the surface of the road only a short distance ahead cuts off the vision beyond, as the eye always adjusts itself to the brighter area in the line of vision. Because it could not give a range of vision without glare, the parabolic reflector was abandoned.

Consideration was then given to the hyperbolic reflector which, Mr. Ryan explained, projects a dome of light with a bright center so that instead of a curve with a sharp point it produces a curve with a square cut-off on top. It throws a "doughnut" of light on the road and as the longest rays cut a crescent across the road, lights both ditches. However, it also produces a dark spot on the road and an inverse crescent of bright light near the car, which is bad.

To overcome the foregoing objections, a reflector was devised that inverts the lower crescent to correspond with the upper one so that it projects the light in an intense upwardly curved crescent. The lens fitted to it has very shallow prisms that refract light to the center and others that bend rays outward to the sides of the road.

Specifications for a Satisfactory Head-Lamp

Before an automobile head-lamp can take its place as a decided improvement over existing equipment, said Mr. Ryan, it must meet specifications as follows:

(1) A non-glare unit having a range between 200 and 300 ft. on a level road, non-focusing and capable of operating with lamps of any form of concentrated filament or candlepower without change of focal adjustment

(2) Light-distribution of fairly wide characteristics with reasonable depth and homogeneous, with a gradually increasing intensity from a point near the machine to the most distant point, and the reflected beam could not rise above the horizontal

(3) A reasonable amount of light projected at right angles to the plane of the main beam and even a few degrees to the rear, to light gutters and curves, make turns at difficult places safe, and also make possible the reading of road signs on either side without use of spot-lights or other auxiliary lamps

(4) Sufficient light should be thrown on the radiator, forward wheels and bumper of the machine, and the upward high-candlepower rays of the beam should be cut off so that they will not scatter in fog and reduce visibility.

(5) Unreflected light should be dispersed to illuminate trees, telegraph and telephone poles and give general vision without glare so that distance can be judged at night as in daylight driving

(6) The head-lamp should be definitely focused for city and country driving to avoid the necessity for dimming, tilting or other manual operation

The area of greatest intensity should not be concentrated in a small spot of high candlepower, but should have a reasonable lateral diversion, continued Mr. Ryan, and it is important to remember that an intense spot introduces a new element of glare by reflection from a wet road-surface. If the non-glare characteristic of the unit is further improved by lighting the front of the machine and the general surroundings, the intensity of the bright area becomes less brilliant by contrast. Furthermore, the main beam should become even less brilliant as the car is approached from in front which will improve the ability of the approaching driver to see beyond the car at the critical moment and also show the driver behind the light the side of the road on the right so that he will have more confidence in keeping near it to give more space for a car passing on his left.

The two-filament lamp is good for use in ordinary reflectors to improve the present intolerable night-driving conditions, but to put such a lamp in the head-lamp is a backward step, according to the speaker, because if lighted to give visibility at 300 ft. it is very glaring and if the other filament is switched on, the visibility range is too short for safety.

Mechanical Requirements To Be Met

Mechanical requirements for a fully satisfactory lamp were enumerated as:

(1) Adaptability to modification of design to harmonize with the lines of the car and to suggest that the unit is primarily a functioning light rather than a decoration

(2) Sufficient rigidity of construction so that it cannot easily get out of adjustment

(3) It should be dust-proof and damp-proof and a simple means of opening the doors should be provided

(4) It should have some simple means of adjustment of the beam which will not require bending of the forks, difficult manipulation or technical knowledge

(5) Cost of production must not be prohibitive even for low-priced cars, and the head-lamp should not be subject to wide variation in production

The foregoing specifications have been met, according to the speaker. The new lamp is flat in appearance, very shallow, and at first glance many might not like its appearance.

Throws Light to Sides and Backward

A series of many lantern slides were thrown on the screen to show comparative illumination by different types of head-lamp in contrast with the new lamp. In running comment on the slides, Mr. Ryan said that he cannot put on the market the new type of head-lamp that he would like, and which might be called an ideal head-lamp, because of the requirements in different State laws, and it will be 5 years before we can reach that stage, which will have to be reached in about three steps. He has taken as big a step as he dares to take in producing a head-lamp that will meet present glare conditions and conform with State laws. It is a real problem, he said, to get through the maze of legal requirements and still give the public a good light.

Something we never have had in headlighting is head-lamps that would make it possible to read road signs and even see behind the front of the car. The new lamp throws light fully 10 deg. back of the front line of the car and in some of the tests made, it was found that drivers of motor-coaches equipped with these head-lamps unconsciously almost invariably nearly doubled their speed because of the greater confidence given by the side illumination.

With the car on the right side of the road, the new lamp throws 53.6 lumens on a target 3 ft. above the road and 100 ft. distant, whereas the next best lamp gave only 33.6 lumens and others down to 11 lumens. With the car in the middle of the road, a lamp with a more intense beam-center gave 63 lumens as compared with the next best lamp giving 37.1. With the target 200 ft. distant and the machine on the right-hand side of the road, the lamp gave 20.3 lumens, which was double the next best lamp. Given such illumination on targets 100 and 200 ft. apart, all of the distance between must be well illuminated.

Men Near Lamp Visible from Ahead

Many slides were shown of the company's testing stations and of tests made from them for comparative purposes. For example, in one photograph taken from 50 ft. ahead of the car, two men standing 4 ft. to the side and 4 ft. in front of the car were clearly visible in the side light of the new lamp whereas, when customary lights were turned on, the men could not be seen.

Concluding his remarks on headlighting, Mr. Ryan said that the workers in his department do not feel that they have reached the ultimate but believe that they have produced a head-lamp that will be of great benefit in reducing accidents and making night driving more pleasurable. The rest of his most entertaining address consisted in brief running comments on a series of more than 100 slides of special illuminations at exhibitions, celebrations and public buildings, of military searchlight and other equipment, and so on. One series of slides consisted of basic pictures to be used in a history of lighting from the most primitive days to the present time. An appropriation of $200,000 was made in 1917 for the production of this picture and after a great deal of research work it is now being made ready. It begins with the Egyptian drill of 4000 or 5000 years ago and follows through the different methods of starting fire and of producing a constant light. It is surprising to know, said Mr. Ryan, that the cost of producing one candlepower of light 100 years ago was 200 times the present cost. This represents the great advance in the efficiency of generating apparatus, light and units of different kinds.

Better Lamp Producible when Laws Permit

In the discussion, Howard F. Ilgner, superintendent of electric service of Milwaukee, said that he believed that the basis of the present headlighting laws is the present head-lamp; that the laws were not made in accordance with ideals which authorities would like to realize but were drawn according to the practicability of the time and so as to avoid disbarring all of the head-lamps in the market. So far as the law in Wisconsin is concerned, he believed that if it was necessary to have better laws not much trouble would be experienced in securing the change; the Safety Commission in Milwaukee would be glad to push the matter if the new head-lamp described by the speaker had as much merit as claimed. He believed the Illuminating Engineering Society would be an important agency in remedying the present situation in the multiplicity of headlight laws.

In reply Mr. Ryan said that the Illuminating Engineering Society, of which he was one of the first members, is studying the problem and purposes to work to modify the laws and to bring them up to the development in headlighting. The new lamp as recently put on the market by the company with which he was connected has been passed by all of the States in which tests are required. However, a better lamp can be produced that would not pass inspection under some of the State laws and it is not purposed to produce this for 3 or 4 years until the public and the commissions in the States can be brought to a state of mind in which they will recognize that the development is in the right direction. It was necessary to make a poorer lamp that would pass the tests required in different States. The laws have outlived their usefulness and require modification. Although the present lamp is a great improvement, he said that the company is not satisfied to stop with it but will keep on in an effort to get the ideal lamp in use although it will take 5 years.

W. D'A. Ryan

Roadside Illumination Incorporated in the Lamp

H. L. Debbink, of the Milwaukee Electric Railway & Light Co., asked if there is enough element of safety in throwing an intense beam on the right-hand side of the road to counteract glaring headlights approaching to warrant consideration in developing such a lamp as Mr. Ryan described. Answering this, Mr. Ryan said that there is much merit in throwing a bright light on both the right and left sides of the road but that a spot-light gives too intense a light and does not give proper visibility outside of the bright area. In the new lamp the increased illumination starts from the car and is accelerated to throw a bright spot in each gutter. He prefers to secure this effect with the head-lamp rather than with additional and unnecessary equipment. The driver is better off without too bright a spot because visibility is improved with more uniform illumination.

When asked by W. F. Lent, of the Cutler-Hammer Mfg. Co., if there is any way to prevent the driver of a car from receiving the full intensity of the headlights on an ap-

proaching car as it comes over the top of the hill, Mr. Ryan stated that there is a way but he does not think it can be used at present as it would add too much to the cost of the head-lamp. The new lamp he has developed does not have as high candlepower as the customary head-lamp and the beam lies rather low, so there is less of the upward stray light and as one approaches the light it becomes dimmer and dimmer. When going over the top of a hill the approaching driver passes through the bright range quickly and his eyes have plenty of time to readjust themselves before passing the car.

Glare Prevention the Only Remedy

Mr. Ilgner inquired if it is practical to enforce the headlighting laws in cities the size of Milwaukee with the head-lamp equipment with which most cars are now equipped, including low-priced cars. Mr. Ryan replied that he thought a great deal can be done to enforce the law, as conditions are not so bad in the Eastern States as formerly although the streets are still a blaze of fire. If the authorities had 10 times the force they have they could not positively correct the trouble although they could improve it. The only way that headlighting can be improved is to prevent glare, and that will take time, as car owners will not throw away their present head-lamps until they are convinced that another type is safer for them and they have more regard for other users of the highways. But if leading car manufacturers will take the matter up they can do a great deal to convince the public. The development of the new head-lamp has cost a great deal but the company is trying to reduce the cost of the lamp as much as possible consistent with the use of heavy metal, proper manufacture and careful checking from a scientific standpoint. In Boston, although he has seen 100 cars stopped on one street at a time for correction of the head-lamp, the lamps when adjusted throw a light down in front and have no range, so that there is danger of accidents.

Chairman Young called upon Mr. Kissel, of the Kissel Motor Car Co., which has adopted the new lamp, to tell something of the results that can be expected from it. Mr. Kissel stated that driving with these head-lamps is as near as possible to driving by daylight, as the side of the road is well lighted and one can drive from 20 to 25 m.p.h. faster at night than is safe with the usual headlighting.

Authorities Demanding Better-Built Lamps

Has the price of the lamp been brought down to a figure such that the large car-producers will think they can afford to put them on as standard equipment? asked H. S. Lord, of the J. I. Case Threshing Machine Co. Answering this, Mr. Ryan stated that during the last 25 years no automobile-headlight manufacturer has been in a position to spend money in development work and for that reason it has been necessary to go outside for this development. The time has come when State authorities are becoming very particular not only about characteristics of the light but about quality of the product and its ability to withstand service without getting out of adjustment. Such a lamp must be made of heavier metal than usual and must be simplified and improved in various other respects. We shall have better headlighting in 4 or 5 years because the motor-vehicle commissioners will force the car users to have better head-lamps.

Mr. Browney remarked that motorists have adopted various lights in self-defence against the lights of other road users and said that the only solution seems to lie in the universal adoption of some standard that would make it compulsory for manufacturers to equip their cars uniformly. In reply to this Mr. Ryan stated that when driving behind the new lamp, if the driver watches the right side of the road and does not look at approaching lamps, he will find he can see much farther. In States where dimming is required it is observed that drivers passing a car equipped with the new head-lamps constantly dim their lights in the belief that the other lights are dimmed, but the new lamp requires no dimming or tilting, as it is believed that a driver should not be playing with the lamps when he should be giving attention to driving.

MODERN AIR-TRANSPORTATION DISCUSSED

Cleveland Section Holds Air-Transport Dinner and Talks about Air Travel

The subject of the Practicability of Air Transport was debated at the meeting of the Cleveland Section that was held on April 25. About 100 members and guests attended the special dinner in the ballroom of the Hotel Cleveland, and 150 persons were present at the technical session. The principal address was by L. B. Seymour, chief engineer of National Air Transport, Inc., who substituted owing to the unavoidable absence of Paul Henderson, head of the Aeronautical Chamber of Commerce and general manager of the National Air Transport, Inc. T. V. Buckwalter was chairman.

Preceding Mr. Seymour's address, Orrel A. Parker, president of the Parker Wheel Co., expressed his views on the commercial phases of air transportation. J. V. Whitbeck, of the Chandler-Cleveland Motors Corporation; R. J. Nightingale, of the Willard Storage Battery Co.; G. W. Smith, Jr., of the White Motor Co.; and J. W. McCaslin, of the Equitable Life Insurance Co., all of Cleveland, were other speakers who presented their opinions regarding the public's attitude toward the present use of air-transport facilities.

Regarding reports all too current that the United States is far behind the European countries in commercial-aviation development, Mr. Seymour believes this untrue and said that all foreign air-lines but one receive government subsidies, the one exception being in South America. In his opinion, commercial aviation should not be subsidized, but should be self-sustaining financially. He stated that the main military value of commercial aviation lies in the fact that it develops flying personnel and facilities for the building of aircraft, mentioning the great advance in the development of aircraft during 1926. Comparing the best commercial airplane available somewhat over a year ago with the best one available at present, the former had a 400-hp. engine, a top speed of 115 to 120 m.p.h., a carrying capacity of 1000 lb. and a cubical-content carrying-capacity of about 55 cu. ft., according to the speaker; but the latter airplane has a 200-hp. engine, a top speed of 125 to 130 m.p.h., a carrying capacity of 1000 lb. and a cubical-content carrying-capacity of 122 cu. ft. Progress also has been made in the standardization of aircraft parts.

Existent and Proposed Airways

As indicated on the accompanying map, the existent airways in the United States are already extensive, and the new routes shortly to be put into operation to and from Atlanta will increase the present mileage largely. Mr. Seymour said that the first leg of the transcontinental route is from New York City through Cleveland to Chicago, the second leg being thence through Salt Lake City to San Francisco. An extension of the transcontinental route from New York City reaches Boston. An airway extends from Cleveland to Detroit and thence to Grand Rapids, Mich. Another connects Cleveland with Pittsburgh, and a new route will connect Cleveland with Atlanta. A route already contracted for will connect Atlanta with New York City, through the City of Washington and Philadelphia. The so-called Pelican Route connects New Orleans with the Gulf of Mexico at Pilottown, La., and saves an entire business day in reaching ocean steamships. Separate airways connect Chicago with St. Paul and Minneapolis, with St. Louis, and with Dallas, Tex. An airway extends from Denver to connect with the transcontinental route. Salt Lake City is connected by airways with Boise, Idaho, with San Francisco and with Los Angeles. The airway on the Pacific Coast extends from Los Angeles through San Francisco to Seattle, and a short airway extends thence to the Vancouver line for connection with steamships.

Safety of Air Transport

On the subject of safety of air transport, Mr. Seymour said that during 1926 the remarkable record of 1,250,000 miles per fatality was made by pilots of the Air-Mail Ser-

vice while flying in daylight and in darkness over the New York City, Chicago and San Francisco route. National Air Transport, Inc., airplanes operating between Chicago and Dallas, Tex., an airway about 1000 miles in length, have flown about 700,000 miles without having caused the loss or damage of even a single letter. No serious accident has occurred and no person has been injured. Forced landings due to mechanical trouble have so far been one such landing per 85,000 miles flown. On the foregoing basis, Mr. Seymour's opinion is that air transportation is much less dangerous than it ordinarily is thought to be, especially when operated by competent organizations that employ skilful pilots and use suitable equipment.

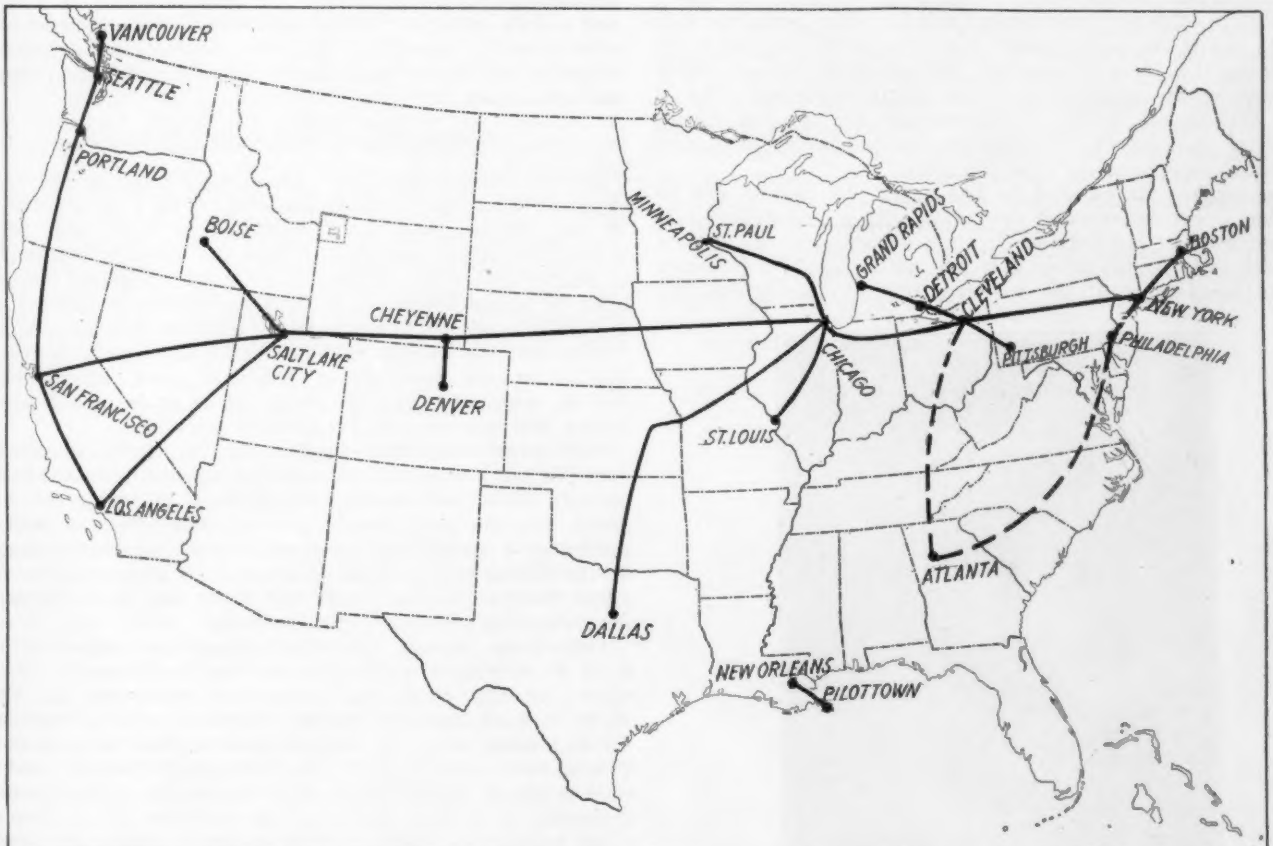
Aircraft and Airway Equipment

Although danger due to fog is now minimized by use of radio beacons, the problem of determining the exact altitude of an airplane with reference to the topography of the country underneath it still remains a serious one according to Mr. Seymour. The distinctive signals from radio beacons are audible to pilots through their telephone head-receivers and are timed so that a pilot can keep on his course whether the visibility is good or not; but the altimeter, although it indicates height above sea-level, takes no account of topography and is not fast enough to indicate small increases or decreases in height satisfactorily. For example, the altimeter might indicate a height of 5000 ft. when over a sea-level landing-field, which would mean 5000 ft. above ground; but, in fog or darkness, if the pilot were flying at the 5000-ft. level the altimeter reading would remain the same even though he might be flying straight into the side of a mountain, and he would crash unless he saw the mountain in time to avoid it.

Upward of 1000 miles of lighted airways have been equipped in the United States in the last year, and Mr. Seymour believes that night flying will soon be possible on other airways besides the one between New York City and San Francisco. This would facilitate the carrying of mail and would stimulate the carrying of packages and light-weight freight.

Describing briefly the lighting equipment of an airway, the speaker said that 24-in. electric-beacons revolving at 6 or 7 r.p.m. are located on 50-ft. towers spaced at intervals of 10 miles and that they are visible in clear weather for 50 to 75 miles. Border lights of small candlepower outline the safe landing-area of each landing-field, and high-intensity flood-lights are used to flood the entire surface of the field with light when the flier comes in. Buildings, chimneys and other danger points are marked by red lights. Each airplane carries a red light on the port side, a green light on the starboard side and a 10-in. landing-light on each wing. The last named are turned on just previous to landing and light the ground in a manner similar to that of flood lights; they are particularly useful when making forced landings. In addition, each airplane carries two parachute-flares; that is, magnesium candles about 4 in. in diameter and 15 in. long which are carried by a parachute of about 14-ft. diameter and which light automatically when released, thereby illuminating about 1 sq. mile of territory so that a pilot can pick out a landing place and get down to it. The candles burn for about 3½ min.

An interesting recent development of the company represented by Mr. Seymour for its new airplanes is that of a detachable engine. By unfastening four bolts, the engine and its accessories, the propeller and the oil-tank become removable. He said that he had seen the engine of the first of these new airplanes removed and a complete, new, tested powerplant substituted in 15 min.



Map of United States Showing Air Routes

The Airways in Operation at the Present Time Are Indicated by Full Lines and the New Routes, Which Will Shortly Be Put into Operation from Atlanta to Cleveland and Atlanta to New York City, Are Indicated by Dotted Lines. The Backbone of This System Is the Transcontinental Air Mail Route from New York City via Chicago, Cheyenne and Salt Lake City to San Francisco with Branches Connecting This Route with Boston; Detroit; Grand Rapids, Mich.; Pittsburgh; Minneapolis and St. Paul, Minn.; St. Louis; Dallas, Tex.; Denver; Boise, Idaho; Los Angeles; Portland, Ore.; and Seattle. The Dispatch and Receipt of Ocean Mails Are Facilitated by Air Routes between New Orleans and Pilottown, La., and Seattle and Vancouver, B. C.

RACING-CAR-ENGINE DEVELOPMENT

Chicago Section Considers High-Speed Two-Stroke-Cycle Engine-Design

Some of the history of the development of racing-car engines and the merits of the two-stroke-cycle compared with the four-stroke-cycle engine for high-speed performance were presented to the 68 members and guests of the Chicago Section who attended the meeting that was held on May 10, at the headquarters of the Western Society of Engineers, by Lee W. Oldfield, consulting engineer in charge of design and development for the Pac-Age-Kar Corporation, Chicago. O. W. Young, sales manager for the Hyatt Roller Bearing Co., Chicago, was chairman.

Mr. Oldfield said in part that the earlier efforts toward an increase in specific output were nearly all directed to increases in compression and in port-areas. Such increases as were possible soon brought about a large amount of trouble with bearings, particularly those in the connecting-rods. This trouble caused a search to be made for some means of making substantially lighter pistons. Thin-section steel-pistons were used as early as 1910, and aluminum-alloy pistons were used to a limited extent in 1913. These light pistons, although far from being satisfactory, almost eliminated the bearing troubles and permitted an increase in engine-speed. But increased engine-speed developed other problems, of which that of the valve-motion was greatest. Some designers attempted to solve this problem by increasing the number of valves, obtaining lighter parts in that way, and those who worked in this direction achieved some measure of immediate success as did also those who designed valve-motions in which the weight of the lifter-mechanism was returned mechanically. As engine-speeds increased, volumetric efficiency was reduced and for some years the only efforts made to compensate for this reduction were by enlarging the areas throughout the induction-system. Some of these efforts resulted in minor gains important only in that, because of failure to accomplish the desired result, attention was thereby focused on the possibility of forced induction, now termed "supercharging."

The speaker stated that he has never felt that it will be possible to get satisfactory operation with a two-stroke-cycle engine without embodying in the design (*a*) a uniflow cylinder and (*b*) provision that will assure positive pressure on the intake-port of the working cylinder throughout the total opening period of that port. The adoption of the uniflow cylinder in conventional designs necessitates the use of some sort of valve, which is objectionable. The second feature can be accomplished either through the use of a blower or compressor, the outlet of which is connected to an intake-passage common to all the intake-ports of the engine; or by the use of crankcase compression, two-stage pistons, or any of the various modifications of the conventional means of obtaining primary compression for two-stroke-cycle engines, by choosing certain numbers of cylinders and by bypassing from one compression-chamber to some certain intake-port having the desired relation. Mr. Oldfield then went on to describe the two-stroke-cycle engine he has developed. The discussion following the presentation of the paper was concerned with details of the design and performance of this engine.

Photograph by Moffett
LEE W. OLDFIELD

TWO PENNSYLVANIA SECTION MEETINGS

Varied Phases of Aviation Activities Analyzed and a Golf Outing Staged

The first of the meetings was held on May 10 and included brief addresses on the possibility of seadromes or refueling stations for transoceanic aircraft, crop-dusting by airplanes, airport and airway lighting for night-flying, and aerial photography. Motion pictures of special features of these activities were shown as well. The second meeting, held on May 13, was devoted to golf, a dinner, card playing and dancing at the Tredyffrin Country Club, near Philadelphia, being the annual Spring Outing of the Section. R. W. A. Brewer was chairman at the technical session following the dinner on May 10, and 66 members and guests attended. Horace S. Meese was chairman of the entertainment committee for the Outing, and 48 persons attended the dinner and dance that followed the events of the afternoon.

SEADROMES AS REFUELING STATIONS

In the opinion of E. R. Armstrong, head of the experimental engineering department of E. I. du Pont de Nemours & Co., Wilmington, Del., transoceanic flight will become a very important industry. Since the airplane nominally is a short-flight craft, transoceanic flight requires refueling stations along the route if it is to become successful commercially, and Mr. Armstrong believes he has made a practicable solution of this problem. Such an airway operating-station at sea must be of adequate area, approximately 400 ft. wide and 1200 ft. long. It must be proof against waves and storms and be securely anchored.

Mr. Armstrong then stated the principles involved in deep-sea anchoring, citing deep-sea anchoring-methods that already have been used successfully. In brief, the great depth and the great length of the cables thus necessitated generates a stabilizing horizontal force, due to the sagging of the cables in the form of a catenary curve and to their great weight. He said that the Navy has made successful anchorages in water 2 1/2 miles deep.

Describing wave-action, Mr. Armstrong explained that it is a movement vertically and not horizontally. Large waves in the open sea, when not broken-up by ships, move onward without lateral movement. The motion is up and down and this up-and-down motion is propagated. The wave movement is on the surface of the sea. Advantage is taken of this fact in that the design of the proposed seadrome is such as to locate 90 per cent of its displacement below the surface. The members submerged in the undisturbed water at the bottom of the structure are equipped with huge damping-discs, so that the period of movement of the structure as a whole is one of minutes rather than one of seconds. In this manner the structure is designed to resist roll and pitch. It is possible, according to Mr. Armstrong, to locate a route across the Atlantic Ocean that is free from ice and freezing weather and is

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clear of 90 per cent of all storms, being also clear of the fog belt. According to his plan, a seadrome would be anchored each 400 miles along this route, although this spacing between refueling and operating stations could be increased to be 600 miles. Mr. Armstrong then exhibited motion pictures of varied wave-tests of a model of the seadrome he described.

Lieut. J. G. Ray, operations manager for Pitcairn Aviation, Inc., Philadelphia, commented upon the character and amount of local flying now being done in the vicinity of Philadelphia. He said that between 25,000 and 30,000 persons made flights there during 1926. In his opinion the problem of selling the idea of flight to the public is a greater one than is the mechanical problem. The selling point for the airplane is speed, since it is faster than any other known means of transportation. On that basis it can be sold, since the engines are reliable enough, the airplanes are safe enough and the pilots are competent enough so that passengers already are reasonably safe during the flight.

Crop-Dusting by Airplane

George B. Post, of the Keystone Aircraft Corporation, formerly Huff, Daland & Co., Inc., Bristol, Pa., showed motion pictures of how airplanes are used to spread calcium-arsenate dust over the cotton fields of the South and thus wage war against the boll weevil. He outlined the history of the development of this aerial activity and described the methods now in use. The dust must be spread everywhere over the field, even underneath the leaves of the growing plants, so that no weevil can escape coming into contact with it; therefore, the dust must be very finely divided, like flour, and must be blown down upon the crop with great force. The hopper in which the dust is carried is equipped underneath with a venturi passage through which the blast from the propeller of the airplane must travel. In this manner the velocity of the air-blast is stepped-up to be about 300 m.p.h. and the dust is applied to the crop in very fine particles and with very great force. An automatic agitator stirs the dust in the hopper continuously. Formerly, when using an ordinary dusting-machine on the ground, the dust would not stick to the plants and the ground unless there was dew on them, but with the present process the dust sticks when everything is dry, this very probably being due to the effect of static electricity. Airplanes fly 10 to 15 ft. above the crop when dusting, and the cost of dust applications is $7 to $8 per acre.

Airway Beacons and Landing Floodlights

The inauguration of night-flying schedules on the various Air-Mail routes and the interest evidenced by the Army and the Navy in night-flying and its attendant equipment for safe operation have combined to emphasize the consideration and development of adequate illumination for airports and airways in the United States, and such illumination was the subject presented by E. A. Leinroth, of the Barbier, Bernard & Turenne Corporation of America, Philadelphia. A comprehensive paper entitled Lighting Equipment for Airways, Airports and Airplanes was presented at the 1926 Aeronautic Meeting of the Society by H. C. Ritchie and C. T. Ludington[1], the latter being president of the B. B. T. Corporation, reference to which will afford access to many interesting details on the subject that are too numerous for mention here, and Mr. Leinroth covered them, as well as later developments, in his address. In the consideration of navigational aids to enable a pilot to maintain a true course Mr. Leinroth said that the development of the radio directional beacon undoubtedly will be an important factor; but, so long as engine failures, unexpected storms and weight and reliability of radio equipment continue to be problems, although the radio beacon will be a very valuable supplement to airway lighting, it can never be expected to supplant an adequate system of airway illumination.

In pointing out some of the features that make the 24-in. revolving beacon of the searchlight type far from ideal, Mr. Leinroth mentioned that it rotates at a speed of 6 r. p. m. and gives a flash every 10 sec., which is not sufficiently frequent. However, it is not feasible to increase the speed of rotation and thereby increase the frequency of the flashes because the duration of each resultant flash becomes so short as to make it impossible for a pilot to pick it up, and the flash would be lost. Even at 6 r.p.m. the flash is so short as to be easily confused with that from an automobile headlight. The need for a distinctive characteristic flash that is informative as to what beacon it is becomes more and more evident as the number of airways increases. Greater reliability under all conditions and at all seasons is needed also.

One modification of the revolving beacon substitutes a wabbler mechanism for the revolving mechanism. The beacon, instead of revolving at constant speed in one direc-

Photograph by Ellis
E. R. ARMSTRONG

[1] See THE JOURNAL, September, 1926, p. 314.

tion, is reversed by the wabbler mechanism so that it comes to a stop when pointing in one direction of the course, then reverses direction for approximately 540 deg. or one and one-half revolutions and comes to rest when pointing in the other direction of the course. Hence, the pilot, when on course, sees a long flash followed by a short flash; but, while off course, he sees short flashes only.

The flashing beacon, used extensively along the airways and at the airports in Europe, represents a distinct type of beacon which Mr. Leinroth believes eventually will be the accepted standard for such purposes. Its principal is similar to that utilized by the Lighthouse Bureau for the assistance of marine navigation. A 360-deg. Fresnel lens throws a beam of light in all directions in the horizontal plane and is visible to the zenith. A flashing mechanism causes a distinctive characteristic flash which affords instant and definite information as to its location. Flashes in code signals, or of any frequency or period of duration desired, are equally visible on course and off course, and the functioning of the beacon is not affected by the elements. Mr. Leinroth then described the floodlights and minor lights used in illuminating airports.

Aerial Photography and Map Making

E. H. Cahill, of Brock & Weymouth, Philadelphia, gave an interesting description of the equipment and methods used in aerial photography, illustrated with lantern-slides. He explained also the process whereby aerial photographs are utilized to make photographic maps that are "to scale."

YOUNG-TIMERS AND OLD-TIMERS MINGLE

Ohio State University Student Branch Contacts with Automotive Experts

The inspiring meeting of the Ohio State University Student Branch that was held at the University Club, Columbus, Ohio, on May 14, was opened by R. E. Price, its chairman, who introduced a certain capable toastmaster, classed as an old-timer, but well known to be Younger, whose given name is John. Following brief introductory remarks, the genial toastmaster called upon F. F. Chandler, chief engineer of the Ross Gear & Tool Co., who delivered an interesting address on the subject of Practical Engineering.

Dean E. A. Hitchcock

Mr. Chandler mentioned the many different lines of engineering and said that the sales engineer may be called the practical engineer. He defined a good sales engineer as one who will not misrepresent what he is selling and who is capable of demonstrating in a practical way the good features of the product so that the prospective purchaser will comprehend these good features and desire to buy it. He said also that the research engineer discovers the basis for a new product or method, the man who may be termed the engineering engineer builds upon this basis and develops the idea, and the sales engineer is the man who determines whether the product is possible commercially. The speaker called attention to the fact that students deal mainly with abstract ideas and with *things*, and he emphasized the importance of combining with such knowledge a knowledge of *people* as to their personality and varied characteristics. Therefore, he urged his hearers to add to their knowledge of things the knowledge of people that is gained by mingling with all sorts and conditions of men. Since each group of people looks upon any given problem from a different viewpoint, each group will be benefited by exchanging views.

E. A. Hitchcock, dean of the University, said in part that only in late years has the automotive industry seemed to realize the possibilities and the importance of its relationships with the engineering and technical institutions. Until recently, it did not seem to appreciate the value to the industry of technically trained men. But now that the industry appreciates this asset better, the speaker urged industry to give these young men opportunity. This would include opportunity for instructors and for students to gain practical experience in shops and in laboratories during vacations, and also opportunity for them to secure positions after graduation. Another means to the desired end would be the establishment, by industry, of fellowships in the technical institutions. A third method of cooperation suggested was that industry make full use of the engineering experiment stations at the different institutions.

Prof. H. M. Jacklin chose Teaching Automotive Engineering as his subject. He described the history and organization of the Student Branch of the Society.

S. L. Bradley, sales manager of the Ross Gear & Tool Co., defined "sales viewpoint" as that scope of vision which enables one to piece things together and visualize things at the outset, his subject being the Sales Viewpoint of the Individual. He said that sales viewpoint has also been defined as that larger and broader scope of men, things and conditions necessary for success. In other words, sales viewpoint is the ability to interpret some of the needs and wants of mankind and a striving to fulfill them, an ability to appreciate what is good business, or constructive, and what is bad business, or destructive. It means working in accordance with the fundamental law of cause and effect. Closely allied with, if not actually an essential element of, sales viewpoint is the idea of service. On this last account, the speaker advised the young men who are about to start out in the business world to think more about what they are going to contribute to the benefit of mankind than they think about what they are going to get.

Prominent among the other speakers was C. B. Veal, research manager of the Society who said in part that the practical engineers seem to him to be the practising engineers, and that they are leaders in the application of the fruits of research. Industry relies more and more upon the application of fundamentals that can be developed only by research. He then enlarged upon these expressions of opinion.

Prizes were awarded for papers presented in competition, as follows: to A. L. Hileman, first prize for his paper on Factors Influencing Detonation; to F. E. Ullery, second prize for his paper on Present Status of the Diesel Engine; and to A. S. Barneman, third prize for his paper on Evolution of the Straight-Eight Motor-Car. A prize was also awarded to H. L. Cannell for having contributed most to the work of the Society throughout the year.

METROPOLITAN SECTION HOLDS MYSTERY SESSION

Taking a leaf from the program of the Annual Meeting last Winter the Metropolitan Section staged a Mystery Session at Hotel Woodstock on May 19. An inkling of the surprise was given when a row of familiar faces, mostly of past officers of the Section, appeared at the head table at dinner. After the dinner Chairman Glynn proceeded to unfold the mystery.

The first speaker called upon was Joseph A. Anglada, who was a Section officer a dozen or more years ago. Mr. Anglada gave a historical sketch of the organization of The Society and the first 10 years of its life. Then followed brief remarks by a number of the former Chairmen of the Section, beginning with R. McA. Lloyd, who was Chairman during the year 1916-1917.

Each former Chairman recalled some outstanding achievement of the Section during his term of office, and thus gave the high spots of the history of the Section up to the present time. This was given in such a delightfully bantering and intimate way that everyone was hailed by his first name or nickname. Even when "the girls" were called for they were "Judy" and "Ad," and later on, during the more formal part of the meeting, no one seemed to notice that when Mr. MacCoull rose to offer comment on Mr. Blanchard's paper, the chair recognized him as "Mr. Neil." After Mr. Lloyd the following Past Chairmen spoke:

H. G. Macomb,	1917-1918
C. F. Scott,	1918-1919
A. M. Wolf,	1920-1921
H. W. Slawson,	1921-1922
W. E. Kemp,	1922-1923
C. T. Myers,	1923-1924
Neil MacCoull,	1925-1926

Chairman Glynn then commended the work of the Section committees during the year past, particularly the Membership Committee for boosting the membership above that of the Detroit Section and making Metropolitan the first Section to reach a membership of 800, and the Meetings Committee for the quality of the papers provided. He also expressed appreciation of the help of Miss Julia McCormick and Miss Adelaide Bell of the Society office, called them up to the speaker's table and presented each with a tiny travelling bag containing several gold coins.

The meeting was then turned over to Mr. Kemp who said that in the replies to a questionnaire as to subjects on which papers were desired third place was given to the subject of automobile equipment, and that the arrangements for a meeting on that subject had fallen to him as the only equipment man on the Meetings Committee. He introduced Donald Blanchard, editor of the *Commercial Car Journal* and *Operation and Maintenance*.

Mr. Blanchard explained that since the total number of manufacturers whose products might be classified as equipment runs into four figures it is impossible to consider more than a part of them in a single paper. Some large groups, like carbureters and shock-absorbers with 50 makes in each group, have been omitted entirely with the idea that they might better be the subjects of separate papers; and it would be difficult to agree on a selection of which articles would best be described. The original paper embraced over 50 typewritten pages and 41 slides giving illustrations of about twice that many devices. As the reading of this paper would require over 2 hr. a digest was presented explaining as briefly as possible each device shown on the slides.

Mr. Blanchard said that in the design of air-cleaners which are now generally furnished as regular equipment, the objects sought are cleaning efficiency, low resistance, reliability, compactness, ease of installation, and low cost. He illustrated and explained the action of the Imco, United, AC, Handy, Tillotson, Remington, H-W, Protectomotor, and Air-Maze devices.

Turning to brakes, it is not clear why power brakes are used so little in America and so generally in Europe

Donald Blanchard

where drivers are willing to do so much more gear shifting than in America. Fuel costs and taxation do not seem to sufficiently explain the difference.

Four-wheel brakes have brought up the question of pedal pressures, and stiffer connections with self-energizing action have been made to answer on passenger-cars. Four-wheel brakes have not been adopted so generally on trucks, but further development along that line is indicated. In motorcoaches the question must be considered with relation to internal safety, especially if a standing load is carried. The trolley motorman can make it hard for the standing passenger to keep his feet, and four-wheel brakes on dry pavement can give about three times as much deceleration to a motorcoach.

The brake systems shown included Lockheed, with a new compensator to keep the liquid under constant initial pressure; the British Andre-Len expanding brake-shoe, in which the shoe against which the drum normally acts in a direction to reduce the braking pressure is fitted with an outer floating segment that is dragged around on rollers in such a way as to increase the braking pressure; the Osborn, with an automatic adjustment feature at the brake levers on the axle; the Westinghouse vacuum servo, introduced at the last Paris Show; and the Stuade hydraulic servo-brake. Other brakes described were the Renault, the B-K booster, Dewandre, Warner electromagnetic, Hercules, Westinghouse compressed-air, Christensen, Yellow Coach and Brake Blocks.

A few wire wheels were shown, some allowing the steering-knuckle pin to be close to the plane of the tire and some featuring interchangeability with disc and wood-spoke wheels, also a Michelin modified drop-center rim in which the drop is eccentric, the maximum being at the valve stem where a patch or lug is screwed down to hold the casing in place if deflated. At the side opposite to the valve the drop runs out to nothing.

Fuel feed-pumps described were the Remington, the AC and the autopulse. The use of rubber was illustrated by a number of slides showing engine mountings, flexible compilings, spring mountings, covers for brake connections and steering connections, and a shock-absorbing element in a steering mechanism.

Chassis-lubricating systems were represented by the Myers and Madison-Kipp, having oil reservoirs near the bearings to be lubricated, and the Bowen, Bijur, Farmer, Hill, Fer-Mas, Alemite, and Oilometer. Oil-filters and purifiers described were Purolater, AC, Tillotson, Handy, Wall,

H-W, Kingston, and Skinner. Among miscellaneous items were devices for preventing wheel-shimmy on Marmon and Farman cars, one of the latter make consisting of separate steering-screws for the two front wheels; the Moto-Meter spark-plug with self-adjusting gap; and the Ryan-Lite, a head-lamp with bowl-shaped, fluted-glass lens giving a beam-spread of 200 deg., thus illuminating part of the front of the car.

In the discussion Mr. Scott asked if there were on the market any pumps for injecting oil into the cylinders for extra lubrication during the starting period. Mr. Blanchard said that there is a Madison-Kipp device for that purpose, and Eric Geertz, of the Skinner Automotive Device Co., mentioned an interconnection with the starter pedal on the Marmon car that serves that purpose.

Asked as to an oil man's view in regard to the usefulness of oil-filters, George A. Round, of the Vacuum Oil Co., said that automobile men are beginning to do what has already been done by turbine operators. The increased amount of water finding its way into the oil makes more trouble in winter than in summer, and some of the oil-rectifying devices heat the oil to a temperature of 700 deg., hot enough to crack it. The main trouble is that these devices may give car owners a false sense of security so they will not attend to their lubrication as often as they should. There should be some sort of an indicator to show when attention is needed. After abrasive material has passed the pistons and worked into the circulating oil it is ground so fine that it has little abrasive effect, although a chemical test will show its presence.

Jack Hines, of the A. C. Spark Plug Co., replied that abrasive in the oil really does amount to something and the oil-filter removes "sludges." If the filtering element becomes clogged before it is renewed a by-pass allows lubricant to pass. An advertising campaign is to be launched soon to urge owners to test their filters every 500 miles by opening a pet-cock.

J. M. Florida, Eastern service manager of the Packard Motor Car Co., in answer to several questions, stated that the Bijur central lubricating system used on the Packard car is entirely free from trouble unless from some sort of abuse; that oil is more satisfactory than grease for chassis lubrication and that wear of chassis bearing-surfaces had been reduced to one-fifth of what it was with the previous method of lubrication.

J. R. Bartholomew, of the Westinghouse Air Brake Co., compared the importance of the air-brake in handling road-trains to its place on railroad trains. He mentioned a recent test of a road-train having a gross weight of 75,000 lb. Running at 25 m.p.h. it was stopped by the air-brakes in an estimated distance of 50 ft.

TIRES AND THE CAUSES OF TIRE-WEAR

Proper Selection of Types and Attention to Front Wheels Urged at Los Angeles

Some new thoughts on a thread-bare subject were advanced in discussing tire wear at the May 13 meeting of the Southern California Section, which was held at the City Club, Los Angeles, and attended by 112 members and guests. The main themes of two addresses were that tires should be selected carefully as to type for the kind of vehicle and service for which they are to be used and that front-wheel camber, toe-in and caster should be adjusted at the place of final sale of the vehicle to the character of the roads in the vicinity. The first address was delivered by Alvin N. Day, transportation engineer of the Goodyear Tire & Rubber Co., who showed lantern slides of various types of solid, cushion and pneumatic tires and also a motion picture of tire-manufacturing processes. The second paper was presented by Ralph F. Lodge, of the J. S. Bushey Co., specialist in wheel alignment, and was illustrated with slides.

Ethelbert Favary, engineer of the Moreland Motor Truck Co. and secretary of the Section, who made a special effort to have a large attendance and presided at the meeting, brought out a burst of applause by announcing that California stands sixth among the States in number of members in the Society and that the Southern California Section now has more members than the Northern California Section, with which keen rivalry prevails.

In the election of officers for next season, the results, which were announced just before adjournment, showed recognition of the enthusiastic and excellent service rendered by Mr. Favary in bringing about the organization of the Section and in sustaining its activities. He was elected unanimously to the office of Chairman. Other officers also elected unanimously were: O. H. Ensign, president of the Ensign Carbureter Co., vice-chairman; Eustace B. Moore, superintendent and manager of the L. A. Automotive Works, secretary, and J. Jerome Canavan, president of the Canavan Motors Co., treasurer.

Suggestions for topics for meetings next season were called for and after a number had been offered, Mr. Canavan suggested that a questionnaire addressed to the members would produce the information wanted.

Tire Types Suited to Different Conditions

Selection of types of tire made by the large reputable tire companies in sufficient variety to supply correctly the type most suitable for each hauling condition on the Pacific Coast and in accordance with the most exact standards of quality, and the following of the tire companies' advice regarding such choice, was urged by Mr. Day in his address. Slides were shown of a demountable cushion tire, a high-profile solid tire, a heavy-duty tire with renewable-tread design, a truck tire with steel base, a cushion tire with central circumferential cavity, and a pneumatic truck tire.

He digressed briefly to state that at present 2,000,000 pneumatic-tired trucks, mostly of ½ to 1-ton capacity, are in service in the United States, that 333,000 trucks are equipped with solid tires and that 140,000 are fitted with pneumatic tires of 6-in. size and larger. These figures do not include 26,000 motorcoaches. Gains in the use of pneumatic tires on trucks and decreases in the use of solid tires were shown by the following data on estimated registrations of motor-trucks:

		Estimated Registration	
Kind of Tire	1926	1927	1928
Pneumatic	140,000	159,000	240,000
Solid	46,000	45,000	42,000

Efficiency in transportation is based, according to Mr. Day, on two factors: (*a*) actual cost to the shipper and (*b*) time. Cost is often dependent upon time, which is of prime importance in the shipping of perishable freight. In shipping by rail, 60 per cent of the elapsed time between shipper and consignee occurs at terminals. The remedy for this loss is increased trucking facilities. On the Pacific Coast, admirable work is being done, he said, by local truck-freight lines such as those from Los Angeles to Santa Barbara, Los Angeles to San Diego, Los Angeles to Bakersfield, and so on. Yet motor-trucks are today rendering a service of only 16,000,000,000 ton-miles per year, whereas the railroads are rendering 414,000,000,000 ton-miles. Tire costs represent about 26 per cent of the total truck-operating costs, hence the importance of careful selection of tires of the right type and quality.

Tires Adapted for Certain Services

The first tire shown in the slides was a demountable cushion tire for light-trucks, such as Fords, that are used in traffic-congested areas and where sustained speed is not required. Its shock-absorbing properties are not so great as those of pneumatic tires but if the vehicle on which it is fitted is operated at a speed compatible with the service, very substantial economy in operating costs can be obtained. Liability of punctures is eliminated, which is important because of the prevalence of broken crates and other debris on the streets and alleys in wholesale and central-market districts; and it is a good tire for use on small fleets that receive only nominal supervision.

The high-profile solid tire, which is made in only a few sizes, is especially intended for use on front wheels, on all

wheels for service in which the mileage is unusually low and is also applicable to trailers and to trucks operated in distant outlying places and that can carry dual-tire equipment, as no tread recutting is to be experienced. It has not the resiliency nor the tractive property of a tire that has a definite tread-design, but, when used as intended, it results in certain savings.

The heavy-duty solid tire having a definite renewable tread-design is designed for service in which maximum loads are carried and great tractive effort is necessary. The average tensile-strength of the compounds is about 2300 lb. per sq. in., said Mr. Day. Because of the rapid development of high-speed hauling, some of the tire companies have developed special compounds to resist disintegration due to heat. On the concrete roads now general in Southern California and under the heat conditions in Imperial and San Joaquin valleys, tires made of these compounds will deliver, in present high-speed hauling, about 85 per cent of the mileage received from former standard compounds under slow-speed operation, according to the speaker.

Cushion and Pneumatic Truck-Tires

The cushion tire with hollow core and molded from a special compound having great elasticity of resiliency was pronounced the ultimate in steel-base tires as regards cushioning qualities and long mileage. The opinion among truck operators that it is suitable only for front wheels is only theory, as its limitations are (*a*) width of the felloe-band and (*b*) sustained high-speed for an extended time. A common fallacy is that regarding oversizing of cushion tires compared with solid tires. A 5-in. cushion tire, which replaces a 4-in. solid tire, is so marked because it is built on a 5-in.-wide steel base. It has a 1-in. central core to provide for displacement of the rubber in the tread, but the rubber omitted from the core is more than offset by extra rubber in the profile. A 5-in. cushion tire has a volume of about 1600 cu. in. of rubber as compared with 1200 cu. in. in a 5-in. solid tire on the same base-band, while a 4-in. solid tire has a volume of only 900 cu. in.

Pneumatic tires for truck work are coming into use faster than ever, Mr. Day continued. On the Pacific Coast, where the average length of haul is more than four times that of Eastern truck operators, and where long-continued high-speed operation is common, pneumatic tires, especially in dual assembly, will unquestionably give a lower cost per mile with greater tonnage, and generally lower maintenance, than either solid or cushion tires.

Balloon or low-pressure tires are the latest development for truck equipment and are coming rapidly into use on trucks and motorcoaches, as they give greater safety and greater continuity of service than high-pressure tires. The main advantage is the lower air-pressure, which is about 45 lb. per sq. in. in a 38x8.25-in. tire. An increase of 25 per cent in pressure, due to heat on the road, as in Arizona, and to long downhill work with constant brake-application, is felt only slightly by the tire and the operator or passengers. Blow-outs from excess pressure are much less likely to occur than with high pressure tires.

In conclusion, Mr. Day advised operators using solid or cushion tires to reverse their wheels after approximately every 5000 miles, to observe the schedule of inflation pressures and to see that the wheels are maintained in proper alignment and that the front wheels have correct camber, toe-in and caster. Decided wear or sloughing of the tread on the shoulders of balloon tires has been shown by slow motion-pictures to be due to rotation of portions of the tread on their own axis as the tire revolves on the road, which wears depressions in the rubber. This action has been eliminated by proper distribution of the traction trip on the tread, leaving the tread design in the center line of the periphery.

Wheel Alignment a Service Problem

Premature tire wear caused by improper wheel-alignment is not a problem for the car manufacturer but rather is a service problem that must be handled at the place where the products sold are delivered for use, asserted Ralph F. Lodge, who was introduced to the audience by J. S. Bushey. When cars leave the factory they may represent the acme of automotive engineering and be equipped with tires of unquestioned quality, but they will not all be operated on the same kind of road surface and under like conditions. For this reason tires that may yield their maximum expectancy of mileage on one car may fall far short of such performance on a car of identical design. Road surfaces must be considered and adjustments made to the car to reduce unnecessary friction to the minimum.

The crowned road requires much greater wheel camber than the flat concrete road to permit the tire tread to come into contact with the road surface with an equal distribution of weight on the tread. Hence, when setting a front axle, the camber should be adjusted with the vehicle fully loaded and the weight distributed uniformly on the tire tread on a plane to conform to the profile of the type of road on which the vehicle is to operate.

Desired steering results with 20 and 21-in. wheels will be obtained when front-wheel bearings, knuckle-pins and bushings have only sufficient play to allow free action and from ½ to ¾ in. of camber in each wheel and when the tie-rod bolts and bushings have only play enough to permit free action and toe-in of from 1/16 to ⅛ in. The best amount of caster can be determined after the camber and toe-in have been adjusted. The caster should permit the front wheels to return to their normal position, without resistance from the steering-gear, after making a turn.

Front-Wheel Adjustment Overcomes Shimmy

It has been found, said Mr. Lodge, that when camber, toe-in and caster have been adjusted as described, the tendency of the front wheels to shimmy, romp or wander has been removed, as in most cases these actions are due to friction of the tires on the road. It is essential also that the wheels be in perfect balance to prevent high-speed shimmy. Eccentric brake-drums on front-wheel brakes contribute to slow-speed shimmy.

The speaker contended that every car, before it is placed in the hands of the purchaser, should have its wheels checked carefully for perfect alignment and the weight should be distributed uniformly on the tire tread so that the tires will roll properly on the road surfaces. All car owners, he said further, should be urged by car and tire factories, distributors and dealers to have the front axle, wheels and steering mechanism checked at least every 60 days. Only when this is done will the present widespread trouble caused by improper wheel alignment be overcome.

Some principal causes of premature tire-wear, as given by the speaker, are uneven adjustment of camber of the two wheels, which results in side wear of the tread on one tire; loose steering-knuckles, pins and bushings, which result in a scuffing of the tread and a cupping effect; eccentric brake-drums, which lock the wheels and slide the tires on the pavement at a certain spot on the tire each time the brakes are applied; steering-knuckle arms connected to the tie-rod at unequal distances from the wheels, which unequally divides the turning radius of the right and left wheels and causes one tire to slide more or less when rounding turns; and unequal caster, which often results in the tire on the wheel with the greater caster wearing prematurely due to outward drag of the weight of the car.

Many Questions Asked and Answered

Following delivery of the two papers many questions were put to and answered by the speakers and by P. K. Coe, in charge of the truck and coach division of the Goodyear Company, and by Mr. Bushey. Regarding compounds for high-speed work, Mr. Day said that the Goodyear Company is making truck tires of four different compounds and that branches in San Joaquin Valley carry truck tires of high-speed compounds almost entirely. To this Mr. Coe added that choice of regular or high-speed tires must be based on experience in the individual operation. The difference in compound lies in the relative ability to dissipate heat generated within the tire.

Raised portions of the tread design are placed at a 45-

deg. angle, said Mr. Day, because in skidding a vehicle describes a parabola at an angle to the forward direction of travel. The coefficient of friction is increased materially by the angles of the tread in contact with the road surface. Recutting of the tread design on the solid tires is done usually with a pneumatic hammer, he said, and the object is to provide more room for the tread rubber to be displaced horizontally under load and to increase the tractive grip.

As to the proper amount of camber, toe-in and caster to give truck wheels, Mr. Bushey stated that these vary with wheels of different size and also with road conditions. With 36-in. wheels on a fully-loaded 3-ton truck, equal distribution of weight on the tire treads is obtained with ⅞-in. camber and ¼-in. toe-in. Caster must be adjusted more or less to secure proper counterbalance in the steering of the truck. This may vary from 1 to 4 deg. With pneumatic tires the camber would be reduced to ½ in. and the toe-in to ⅛ in., and the caster would be approximately the same. Non-uniform wear on the two front tires is due almost entirely to unequal camber of the two wheels. Camber must be measured with the truck loaded to capacity so that all the spring in the vehicle will be taking its proper action. It is necessary to have at least ½ in. of camber in each wheel, and it must have enough toe-in to take care of the spring in the tie-rod and allow the tire tread to make proper contact with the road. It is necessary to reduce caster in some cases to the minimum of 1 deg. The axle is not heated in changing the camber; it is bent or straightened slightly while cold, and is not changed more than 1/16 or ⅛ in.

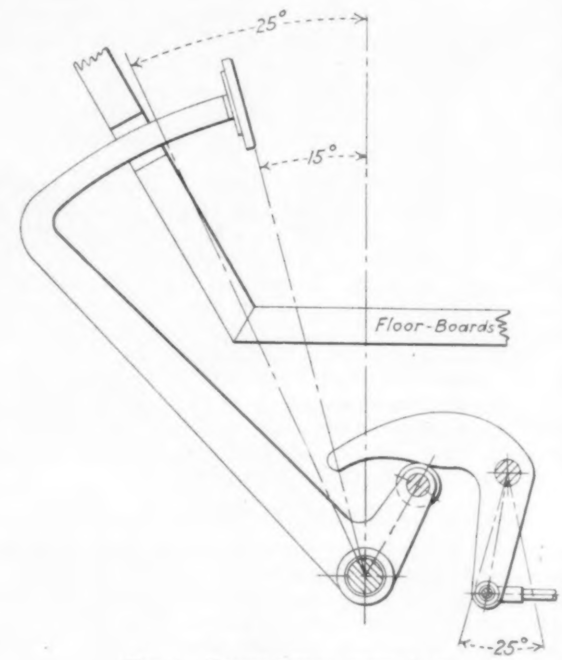


FIG. 1—BRAKE-PEDAL WITH CAM
A Cam Is Interposed Between the Pedal and the Brake-Rod Modifying the Leverage According to the Required Pull

JOHN J. GRABFIELD WINS PRIZE

Woolson Award Closely Contested For by Four Papers. Section Officers Elected.

A good number of members of the Detroit Section assembled on May 5 to hear the papers presented by the contestants for a prize offered by the Section and donated by Chairman L. M. Woolson, as previously announced in THE JOURNAL. Interest in this contest has been widespread and a number of papers were submitted both by members of the Detroit Section and by members of the Society in other parts of the Country.

A committee consisting of J. H. Hunt, president of the Society; L. Clayton Hill, chairman of the Meetings Committee of the Society; and Walter R. Griswold, chairman of the Meetings Committee of the Section, selected the four papers which they considered best. The authors of the papers, in the order in which they were read as determined by lot, were: H. A. Hayden, E.S., a research assistant located in Detroit; F. W. Sampson, Jun.S.A.E., and A. J. Meyer, M.S.A.E., both in the engineering department of the Continental Motors Corporation; Herbert Chase, M.S.A.E., engineer of the Erickson Co., New York City; and John J. Grabfield, Jun.S.A.E., a draftsman in the General Motors Corporation Research Laboratories, Detroit. As Mr. Chase was unable to be present his paper was read by Dr. Burton J. Lemon. After the papers were read the winner was decided by ballot of the Society members present. The vote was close, Mr. Grabfield being declared the winner by a margin of five votes. Mr. Hayden was second choice in the voting. While the vote was being counted, K. L. Herrmann sketched on the blackboard and explained several humorous suggestions for automobile design. After the vote was announced Chairman Woolson presented to Mr. Grabfield the prize of $100 in gold.

COUNCIL MEMBERS ATTEND MEETING

Among those attending this meeting were the members of the Council of the Society, a meeting of which was held the same day. The contest has proved well worth-while from several points of view, and it is to be hoped that contests of the sort may be held by other Sections in the future. Aside from any consideration of the intrinsic value of the material presented, the contest has stimulated the interest and activity of a number of the younger members of the Society and the contestants showed something to the older members in the serious effort they made to present their papers in the most forcible way possible. One of the speakers had committed his paper to memory as an aid to delivery, and it was remarked that the meeting took on almost the atmosphere of an oratorical contest. The suggestion has been made that the winner might better be decided by a committee of judges who would mark the contestants by some system of grading for different points, rather than by submitting the question to a vote of all the listeners, many of whom would not weigh the different points so carefully.

Announcement was made of the result of the ballot for officers of the Section, the following being elected:

W. T. Fishleigh	*Chairman*
B. J. Lemon	*Vice-Chairman*
H. A. Hansen	*Secretary*
E. V. Rippingille	*Treasurer*

L. M. Woolson was elected to represent the committee that will nominate the officers of the Society for the next administrative year with E. V. Rippingille as alternate.

A COMPRESSED-AIR TRANSMISSION

Mr. Hayden in his paper spoke of the conventional transmission as holding the field because nothing better has been developed rather than because it is fundamentally correct. The engine should be run at constant speed and full throttle, and the transmission should convert the power thus produced to the variable speed and power required by the car.

After giving reasons for discarding friction, inertia, electric and hydraulic transmissions for passenger-cars, Mr. Hayden outlines a system in which an air-compressor direct-connected to the engine maintains pressure between limits in a reservoir, being stopped and started automatically according to the pressure. A reciprocating air-engine mounted on the rear axle might be controlled by the accelerator pedal and deliver any required power and speed within its capacity without shifting of gears. As air can be drawn from the reservoir for a time at a faster rate than it is stored the maximum power is not limited by the power of the engine.

Incidental advantages pointed out are adaptability to oil engines and provision of a supply of compressed air for brakes and accessories, especially for the hoists and auxiliaries required on trucks and for the work of contractors.

The Stroke-to-Bore Ratio

In the paper by Messrs. Meyer and Sampson, which was presented by the latter, comparisons were made between long-stroke, small-bore engines and short-stroke, large-bore engines on the basis of cost, durability, smoothness, and performance, the conclusion being in favor of the latter in each case. The cost of an engine is proportional to its weight, and plotting the ratio of bore to stroke of 15 familiar engines against their weight in pounds per cubic inch of piston displacement shows the short-stroke engines to be distinctly lighter.

Mr. Chase's paper said that any manufacturer who resists change simply because it is inconvenient is in danger of losing his place in the race, and credits advertising with accelerating the pace of progress. Improvement can be made by considering fundamentals, particularly weight, and if the car is to be lighter we must either have a flexible body or use the body as a main structural unit of the car.

Stimulating the Imagination

Mention was made of the possibility of converting the energy of fuel directly into electricity; of the advantages of a rotary engine; of the two-cycle engine; and of engines that would give high economy at part throttle or greatly increased torque at low speed. Consideration of evaporative cooling, torque converters and spring axles was also recommended. Few of Mr. Chase's features were suggested as available for use, but their development would not be more surprising than some of the things that have already been done, and the engineer should not close his mind to the improbable.

The last paper, which was read by Mr. Grabfield, is printed below in abridged form.

The Automobile of Tomorrow and the Day After

Progress is dependent upon three primary influencing factors; wealth, initiative and ingenuity. Infinitely more is yet to be done than has ever been achieved. Plotting accomplishment against time we see not only that the curve slopes upward but that its slope is becoming constantly steeper as we make ever more rapid strides. We see this curve from about the year 1900 to present but, in viewing the future we are inclined to assume a tangent from this point on. As surely as day follows night the curve of what is to come will pull away from this tangent.

The automobile of today is a compromise; or, rather, a thousand minor compromises in one. For example, what is an improvement? An improvement is a change or addition that either increases driving safety, increases driving comfort, decreases driving cost, facilitates manufacture or lowers manufacturing cost. An improvement must do one of these things, but only in the rarest of cases does it do all five. An improvement is, therefore, a compromise, and the improvement of tomorrow must accomplish one of the five objects mentioned above without doing violence to the other four. Since the American People are a luxury-loving people, driving comfort must rank next after driving safety, with costs well in mind and manufacturing facility last but not lost.

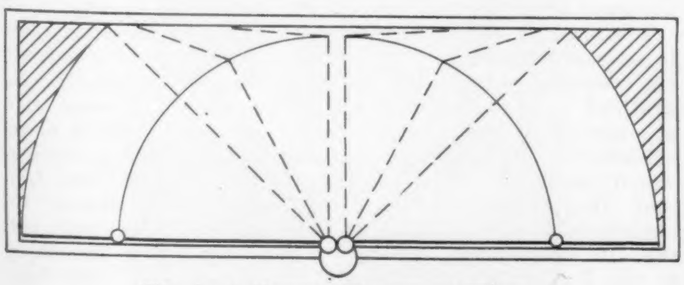


Fig. 2—A Double Windshield-Wiper
The Mechanism Is Mounted in the Center of the Windshield and Actuates Two Arms, Each Consisting of Two Sections Hinged Together

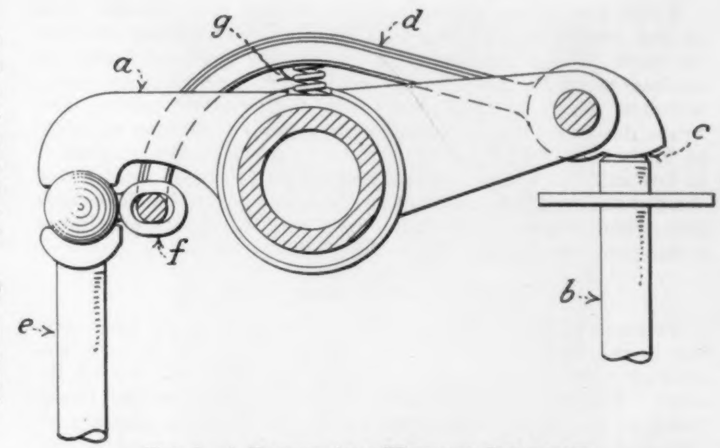


Fig. 3—A Rocker-Arm Without Clearance
Rocker-Arm *a* Makes Contact with Valve-Stem *b* through Cam *c*. Cam *c* Is Made with a Long Arm *d* Extending Across to a Point Near the Push-Rod *e* Where It Connects with a Short Arm *f* Attached to a Ball Floating Between the Rocker-Arm and the Push-Rod. Light Spring *g* Takes Up any Slack

Importance of Brakes

It is more important to stop a car than to start it. Not to start is an inconvenience, but not to stop is a collision. If just half as much time and thought and money were spent in developing a perfect braking system as is spent on the powerplant much would be gained in safety and driving comfort. The driving public willingly exerts an effort of 100 to 150 lb. on the brake-pedal whenever the traffic light changes from green to red, but who would willingly exert a similar pressure to start his car in motion again every time the light turns from red to yellow? The public accepts "hard" brakes because it remembers the buggy days, when more than a woman's gentle hand was required to stop a horse. But how can the pedal pressures be reduced materially in the most satisfactory manner? What type of braking system should be employed?

The only type of automotive brake in extensive use is the friction brake. This transforms the kinetic energy of the car in motion from work units to heat units. The heat units are then wasted. This is fundamentally wrong. The kinetic energy of the car can, perhaps, be absorbed in a more efficient manner by kinetic energy of rotation, as of a centrifugally governed flywheel at high speed; or by potential energy of hydraulic action against a turbine with retarding blades; or the engine that gives the car its acceleration can be employed, through a properly-designed reversing mechanism, to give the car its deceleration also. A fourth way is to utilize the resistance set up in an electrical field by opposing the lines of flux. This is being used at present. However, accepting the friction brake for what it is, what force can be brought to the aid of the driver to help him push? The hydraulic brake is quite satisfactory except that it is not positive in its action, as an oil leak will result in loss of control. The servo or booster brake, used in many European passenger-cars and in some American trucks, serves the purpose well by utilizing manifold vacuum to pull an assisting piston. But in this case the concession to cost is too great for the American passenger-car manufacturer.

The first definite suggestion made is a mechanical "booster" of almost negligible cost. Let us first examine the pedal pressure and travel of a typical brake. Assume the total travel of the pedal about its fulcrum as 25 deg. The first 10 deg. takes up the slack in the system and brings the lining in position to make contact with the drum. During this initial travel, pedal pressure due to the retracting springs increases from 15 to 20 lb. The next 10 deg. does the actual braking, the pressure increasing nearly in proportion to travel from the initial 20 lb. to about 150 lb. at the skid point. The last 5 deg. of travel is to allow for wear, but if, after skidding the wheels, the driver continues to exert increasing pressure due to excitement or ignorance, the added force overstresses the weaker parts of the braking system,

From the above analysis it is evident that of the total 25 deg. travel, only 10 deg. is used in actual braking. Neither the first 10 deg. of taking up slack, nor the last 5 deg. of useless pressure requires as much leverage as they have, whereas the 10 deg. of actual braking requires more. The brake described above has a constant 4-to-1 leverage of pedal to brake-rod. If we now redistribute the leverage so that it is low at first, high in the center of pedal travel, and lower toward the end, and so that the average of all the leverages throughout the travel is still 4 to 1, we will reduce maximum pedal-pressure without increasing pedal travel.

HOW A CAM WOULD WORK

This can be accomplished both easily and cheaply by inserting in the system a bell-crank, as shown in Fig. 1, with the desired cam shape developed along the edge of one of its arms. This is actuated by a roller attached to the brake pedal at the point where the brake-rod would ordinarily be attached. The brake-rod is now fastened to the end of the other arm of the bell-crank. The cam can be shaped to give almost any desired maximum leverage, so long as the average leverage of 4 to 1 is maintained. This design will result in increasing the pedal push to not more than 25 to 30 lb. while taking up slack; decreasing the push about 50 per cent during normal braking, bringing the 100 lb. push down to 50 lb.; decreasing the push 20 per cent at the skid point; and increasing the push immediately beyond the skid point, preventing overstressing of parts.

WINDSHIELD VISIBILITY

Next to brakes the biggest factor in driving safety is 100-per cent windshield-visibility in all weather conditions so that the driver will know when to use his brakes. The present wiper clears only about 15 per cent of the windshield at best, and is useless against sleet and inside mist.

W. N. Phillips at the Annual Meeting of the Society in January passed around a chromium-plated spoon containing a drop of water. The water, instead of spreading over the surface of the spoon, was gathered into an almost perfect spherical globule. The explanation is that the surface of chromium-plate is microscopically smooth and non-porous, as well as extremely hard, therefore the drop of water was affected more by cohesion than by adhesion. Why not develop a similarly smooth surface for glass? Plate it transparently or varnish it or buff it, but develop a treatment to give the absolutely smooth surface that will cause the raindrops to run off.

Windshield misting is caused by the fact that on cold days the inside surface of the glass is colder than the atmosphere inside the car. Part of the moisture in the enclosed air is therefore precipitated on the cold surface in the form of mist. By making the windshield of two pieces of glass with a sealed air-space between them this misting would be overcome. If a tight seal is impractical, the air space could be partially evacuated by a rubber tube connected to the intake manifold. If the double glass were combined with the specially prepared glass surface described above there would be no more need for a windshield wiper, as the sleet problem would also be solved. The outer glass of the windshield would have the same temperature as the outside air, therefore the ice particles would not be fused to the surface but would bounce off as hail.

A 90-PER CENT WINDSHIELD-WIPER

But, as in the case of brakes, let us rebuild the present windshield wiper. Fig. 2 shows the windshield wiper I propose as the second definite suggestion in this paper. The operating mechanism is placed above the windshield, as usual, but in the center instead of in line with the driver. Two primary scraper arms are used, one actuated directly by the mechanism and the other driven from the first through two stamped gears. These arms begin their motion 180 deg. apart and meet in a vertical line, each traveling 90 deg. The length of these arms is made such that in their bottom position they fall just short of the lower edge of the glass.

To the free ends of these arms are pivoted secondary arms long enough so that they, with the primary arms, completely span the width of the windshield. During the downward motion the secondary arms travel in line with the primary arms until the ends of the former strike the lower edge of the windshield. Since they are pivoted, they can fold as much as necessary to permit free action of the primary arms. The action of these arms will cover about 90 per cent of the windshield surface instead of about 15 per cent.

The present forms of spring control by shock-absorbers, snubbers and stabilators are criticized because they hold the body down only by lifting the axle up. The third definite suggestion of the paper is a gyrostatic control consisting of a fly wheel with a fore and aft shaft, the rear end connected to the rear axle and the front end connected to the frame. If the flywheel is placed closer to the front end than to the rear end of the shaft it will control the action of the chassis much more than the action of the axle. A single unit can control the whole chassis.

To give an idea of the amount of control that can be secured in this way, a flywheel 1 ft. in diameter with a 30-lb. rim rotating at 3000 r.p.m. and an axis of rotation subject to an angular displacement of 25 deg. in one second will offer a resistance of 865 ft-lb. At 6 in. from the flywheel this would amount to 1730 lb. and at 4 in., 2500 lb. A variable-speed friction-drive with centrifugal governor is proposed for driving this flywheel from the rear axle to constant speed.

The last definite suggestion offered is a new form of rocker-arm for overhead valves, to eliminate the need for clearance at any point between the cam and the valve. This would eliminate tappet noise, nullify the effect of expansion from heat and simplify the cam contour. Referring to Fig. 3 it will be seen that the rocker-arm makes contact with the valve-stem through a cam instead of directly. To the cam is attached a secondary arm extending to a point near the opposite end of the rocker-arm where it engages with a projection on the ball interposed between the push rod and the rocker-arm. The connection is such that motion of the secondary-arm will cause rotation of the ball. When the valve is seated there is little resistance to rotation of the ball and a light spring serves to keep the cam in contact with the valve-stem. When the valve is off its seat the full pressure of the valve-spring acts upon the ball and it then cannot be rotated by the pressure from the secondary arm. The leverage ratio of the secondary arm and its cam is 25 to 1.

THE UNIVERSITY AND THE INDUSTRY

Their Cooperation Urged at Indiana Section Meeting at Purdue University

The last monthly meeting of the Indiana Section for the season was held at Purdue University, Lafayette, Ind., on May 12. The afternoon was spent in observing laboratory tests under direction of Prof. G. A. Young, head of the engineering college, and H. A. Huebotter, associate research professor. Dinner was served at the Purdue Union Restaurant, followed by the technical session, and F. F. Chandler, of the Ross Gear & Tool Co., acted as toastmaster and chairman. The dinner meeting was attended by 80 members of the Section and of the University faculty.

President Elliott, of the University, had been prevailed upon to address the meeting briefly and in the course of a humorous speech of welcome said seriously that the University was gratified to have brought to its campus the engineers who are aiming to improve and render the motor-vehicle more efficient for the benefit of mankind and that the gathering would encourage those of the University staff who feel that they have something of a scientific nature to contribute to the solution of this problem. He predicted that 10 years hence, when a similar gathering assembles at the University and reviews the automobile of that day, it will find that some of the cars of today and of past years will not be stored at the back of some dealers' place of business, but will be found in a museum as the record of

mistakes made by automotive engineers in the year 1927. Men who believe in the University must of necessity believe that mankind does not stand still. They believe in the philosophy of progress. He concluded with an expression of hope that the engineers had learned something at the University and were not too proud to admit it, because pride of ignorance stands at the bottom of the improvement of the automotive vehicle in rendering it safer for ignorant human beings.

Toastmaster Chandler offered an apology for the absence of students at the meeting due to a military inspection by inspectors of the United States Army, in which about 1800 students in uniform executed maneuvers. He then introduced Dean A. A. Potter, of the University, who, he said, originated many ideas in university teaching that had been adopted by many of the large institutions of learning in the Country.

University Can Help Industry on Problems

It is rather stylish, said Dean Potter, to find fault with the present order of things, to decry the tendency of the young people of today and to say that people are driving too many automobiles and that our present engineering civilization is not the best sort. His contact with thousands of young men during his 15 years as a dean leads him to conclude, he said, that the young people of this generation are very much of an improvement over those of a generation ago. Most of the people who decry the automobile because it enables every sixth person in the Country to go at any time, at any speed, in any direction, do not appreciate the importance of the automobile in our daily life. It is the same with other things; they see little value in the work of scientists or engineers and nothing to commend about the present mechanical and scientific civilization.

Members of the faculty of Purdue University who are concerned with engineering education realize that stability of society depends on the things for which engineers and scientists are responsible and on the type of young men who are being trained. They feel keenly that engineering education and industry are interdependent and that the future of one depends upon that of the other. Executives in industry depend on the universities to turn out engineers who have superior qualities of character, who can think clearly and logically and who have the personality and qualifications that enable them to cooperate with others and work as an integral part of an organization. On the other hand, the executives in industry are interested in aiding the universities to create new knowledge and extend the knowledge to people in the various industries in which they are engaged.

G. A. Young

H. A. Huebotter

So far as engineering is concerned at Purdue University, the University owes its existence to a cooperative agreement between the United States Government and the State of Indiana to give technical education. The institution has 3800 students, of whom 2178 are studying electrical, chemical, civil, and mechanical engineering, and the institution is now training more students in engineering than any other college in the Country. It is trying to train these men to be of a type that will be most acceptable and useful to the industries of the State and Country, and is also trying to add something to the total of human knowledge pertaining to industries, utilities and public works.

He said that instructors feel that research work in an engineering school is of value not only in creating new knowledge but in training men to explore new fields and develop initiative. It is impossible to train men to have initiative and creative ability unless they are brought into contact with professors and research workers of this type. He is convinced, he said, that men in the automotive industry can be helpful to the universities and indirectly to their own product by giving the universities every opportunity in connection with those problems of value to the industry and which can be solved by the universities. Many problems in the industry probably belong to the research laboratories of the university, and by supporting such research the industry will make it possible for the university to turn out young men who will prove of great value to it.

Must Train Men How To Think

Speaking on the relation of automotive industry to the university, J. H. Hunt, president of the Society and formerly head of the electrical division of the General Motors Corporation Research Laboratories but now attached to the Chevrolet Motor Co., remarked that two things that the industry wants of the university is men and facts. The men needed must be trained to analyze and to think independently. The first function of the university is to train men to think, because how they think is of immensely greater importance than what they are thinking about when they leave college, since they must change what they think about and change their ideas a great deal afterward, but it is very difficult to change a man's way of thinking after the years he has spent in college. They must be trained to be students in such an industry as the automotive indus-

try, as it is necessary for men working in this field to adapt themselves to changed situations. This study does not take the form of reading text-books, however.

To be successful in the industry, the young men must be teachers as well as students. Mr. Hunt here referred to a survey made recently by the American Management Association of the disposition of executives' time and which showed that 90 per cent of the time of an executive is spent in educating the men under him. He must have been a student to have understood the problem and to have analyzed it to the extent that he had acquired the viewpoint to give to others. This is the day of the educational executive. Executives with whom he has contact, he said spend most of their time, not in forcing men to do things, but arranging work so that the men see for themselves what is to be done and do it gladly.

Knowledge of Fundamentals Most Important

The facts that are wanted are on fundamentals. It is vastly more important that boys leaving a university shall understand what an engine indicator can tell them about an engine, and that they be made to understand the indicator problem so well that they could produce an indicator free from limitations that might be inherent in a given indicator, than for them to know what an indicator tells about any specific engine. The problems worked on in the university laboratory are different from those in industrial laboratories into which the young men will go. The method of work is the important fact that the boys should carry away with them rather than the results of any particular test.

Similarly, it is far more important that they should know fundamental facts of physics and chemistry than the latest methods used in some engineering laboratories to solve a specific problem. Many young men after leaving college begin collecting data, but unfortunately do not know enough about what they are seeking to accomplish. They would be better off if they took fewer data and analyzed these so that they could carry the main fundamental relations entirely in their heads. This would be more useful to them than an encyclopedia full of tests of every automotive engine produced in America.

Five Lines of Activity Open

When young men leave the university they can go into any of five main lines of activity in the automotive industry as in any other manufacturing industry. These are administration, finance, sales, production, and engineering. A university training in engineering does not apply directly to finance; many young engineers are drafted into sales work by way of engineering and a great many progress to administrative positions of more or less importance through engineering work. Engineering training does not necessarily qualify men to become administrators but it certainly is no handicap in the automotive industry, and in these days when the whole organization must work together, the engineer has as good a chance to reach an executive position as the head of any other activity, provided he is of proper caliber and that the opportunity develops.

The rest of Mr. Hunt's address was devoted mainly to remarks regarding opportunities in the automotive industry, the probable future of this line of work, salaries paid, and an explanation of organization charts along the lines of his address at the Students' Meeting of the Metropolitan Section in New York City on Feb. 16, 1927, as published in the May issue of The Journal. In reference to automotive research work he said that a change in viewpoint has occurred recently and that there has been a tendency to realize that, in going forward on the present basis, the field may be developed to a point where the industry is likely to meet the bogey of saturation. In one sense we now have an incipient saturation, as we are at the saturation-point when it is necessary to scrap an automobile when a new one is sold. The industry is getting close to the saturation-point when, to sell 3,900,000 motor-vehicles in the United States in a year, more than 1,000,000 cars must be scrapped, as was the case last year. Some companies are giving serious consideration to this situation. One way to maintain production when saturation is produced is to provide a stimulus for scrapping by producing a new car that has so much appeal that the owner of a previous car will take the loss of whatever sales value the old car may have in order to acquire one of the new models.

He included an artist in the body-engineering division in the organization chart for an engineering department of a large car manufacturing company, said Mr. Hunt, but frankly he does not know where to secure the kind of artist that is necessary. The artist was put in to emphasize to engineers that there is a phase of the work that they must understand themselves or assume the harder task of educating in the technical details of the automobile someone who understands art. Those who are responsible for body work must have an artist to educate them.

Engine Requirements for Contractors' Machinery

The final address of the meeting, by A. C. Staley, of the Northwest Engineering Co., did not deal with university training but pertained to the application of the internal-combustion engine to contractors' machinery. He treated at some length in this connection with the strong present trend toward the use of the Diesel-type engine. The contractor's machinery to which he referred is portable, has track laying equipment, a cab or chassis that rotates 360 deg. on the running-gear, and has a crane, drag-line, grab-bucket or shovel for different types of work. Up to a few years ago the steam-engine dominated this field and the nature of the work requires steam-engine characteristics rather than those of the internal-combustion engine. For this reason the application of the latter type of engine is surrounded with some very interesting problems. It is necessary to have an engine that gives unlimited service with almost no attention in the hands of very unskilled operators. He cited an instance of an engine on such a machine that had operated 20,000 times a day for a year without overhaul and that was still running fairly well.

Comparing the Diesel-type oil-engine with the automobile-type Otto-cycle engine for service on such machinery, Mr. Staley said that the former has an advantage so far as fuel costs are concerned but is a somewhat more complicated prime-mover and is likely to cause trouble in the hands of unskilled operators. It is a question whether the Diesel engine is justified in work in which the service is intermittent and the load light, and he felt that the high first-cost and the possibly higher maintenance or operating cost makes the question of selection of the gasoline engine or a Diesel engine one requiring some thought. He suggested that an opportunity for future development or trend lies in increasing the reliability factor by making bearings more ample in proportion to other parts and by giving great attention to materials. He thinks that cylinder materials that are better than average should be used in engines for this class of industrial work. Pistons must be fitted as loosely as possible, but must not develop noticeable looseness after 6 or 8 months of service. Close tolerances must be observed, as a difference of 0.001 or 0.002 in. may mean success or failure of the unit.

The Diesel engine, because of its thermodynamic superiority over the Otto engine, has a relatively flat efficiency-curve and it also uses a low-priced fuel. These facts are important because part-load economy is a very important factor of average daily cost of operation in this kind of service. The gasoline type of engine suffers by comparison and consequently efforts have been concentrated on attempts to improve light-load operation by better carburetion and manifolding and by control of the ignition and heat of the mixture. Part-load fuel consumption is subject to considerable control if a mechanism can be produced that will take care of the variation without being unduly complicated. It is possible by spark control alone to reduce no-load and part-load consumption as much as 15 or 20 per cent. Considerable latitude for improvement exists above the cylinder-block, in the head, manifolding, and general handling of

the fuel in the engine. In engines operating with governors it is necessary to have as close regulation as possible between light and fuel-load operation so that maximum power of the engine may be developed with the least drop in speed.

Pitfalls in the Diesel-Engine Field

Nearly all industrial-engine builders are planning to bring out Diesel engines in the near future, but Mr. Staley thinks that substitution of the Diesel engine for the customary Otto-type engine should be undertaken with considerable care, as, although the Diesel engine probably represents an advance in engineering development over the other type, several fundamental conditions are involved that should be given careful consideration before the Diesel engine is accepted from a reliability viewpoint as a real competitor. The modern type of Diesel engine which will start from cold on one turn of the crank must have a pressure approximating 500 lb., which means high pressure on the top rings of the pistons with resultant serious ring-wear and cylinder-wear, which is probably from four to six times as great on the best engines of this type in this industrial service as on a good gasoline-type engine.

With an engine of necessarily small cylinder-bore for use in this service and which operates at relatively high speed, very little time is afforded for vaporizing the relatively heavy fuel after it is injected and the space above the piston in which to burn it is almost insignificant. As a result, fuel is deposited on the cylinder-walls and crankcase-oil dilution occurs. The lubrication problem is therefore tied up with combustion to a large extent and with high initial-pressure to a secondary extent, and until these are well worked out, it must be borne in mind that the maintenance cost is higher and will offset the lower fuel-cost. When this maintenance cost is added to the higher initial-cost of the Diesel engine, a differential is created that will take some time to work out. Notwithstanding this condition, said the speaker, the Diesel engine pays its way in heavy-duty work in many classes of service. But there is a tendency to enter the Diesel-engine field hurriedly without taking these factors into account.

Low-Grade-Fuel Otto Engine Suggested

As another field of development which would be interesting, the speaker suggested the possibility of adapting the Otto-type engine to burn relatively low-grade fuel. Although it might not be possible to obtain the same thermal efficiency as with the Diesel engine, a distinct saving in fuel cost with a relatively low-cost prime-mover might be realized, together with the probability of a much lower repair cost. This would require careful investigation of how to handle the fuel before it entered the engine, which is tied up with careful redesigning of the prevalent type of engine to eliminate hot-spots and a tendency to preignition. Cooling-water circulation also needs great improvement.

The industrial-engine field offers attractive possibilities in this latter connection because the service is intermittent, the speeds low, and the nature of the work permits the use of relatively small valves and affords a chance for the engine to recuperate at its full load about 30 per cent of the time, hence cooling is relatively simple. The demand for engine flexibility is not second to that in any other type of service and is somewhat difficult to meet in the adaptation of low-grade fuel to gasoline engines.

FACTORS OF SATISFACTORY OPERATION

Northern California Section Studies Brake-Linings, Steering and Pavements

How the foregoing factors influence the economics of motor-vehicle transportation was brought out in the three papers presented at the meeting of the Northern California Section that was held May 12 at the Engineers' Club in San Francisco. Entertainment which was enjoyed by the 92 members and guests was provided during the dinner preceding the technical session, and the papers were well prepared and well received. Edwin C. Wood was chairman.

Special Types of Brake-Lining

In presenting the first paper, F. A. Gerrard, Pacific Coast manager for the Russell Mfg. Co., Middletown, Conn., said in part that satisfactory braking of a motor-vehicle depends upon whether the brakes themselves are suitable mechanically, simple to adjust and constructed of material which will withstand the service expected of it, and that brake-lining must be of a quality and type which is suited to the brake on which it is to be used. To this latter end, the company represented by the speaker has been developing special types of brake lining to meet certain requirements. One of these is a hard-pressed woven brake-lining which has been found satisfactory in many cases where a soft woven brake-lining would not suffice, as on motor-trucks. Another product is a brake-shoe, the process of manufacture of which is as follows:

Asbestos is shredded, placed in a vat and assembled into layers in much the same manner as paper is made from pulp. The thin layers are removed from the vat and are laid upon each other until thick enough so that, when pressed, the brake-shoe will have the desired thickness. The assembled layers are then cut to proper length and the strip that is to become the brake-shoe is pressed in a steam press to the desired form and dimensions. It is then removed and is baked for about 20 min., being held to form until it becomes cold, after which it cannot be bent and heat will not soften it, according to Mr. Gerrard's statement. The brake-shoe is then finished upon its edges, and is drilled to provide means for attachment. The finished brake-shoe thus has more than twice as much asbestos in its composition as can be included in the same cubical content of woven brake-lining, which greatly increases the amount of wear that it will withstand.

Mr. Gerrard said further that although the coefficient of friction of the brake-shoe is not as great as that of soft woven brake-lining, it is designed to be used on brakes that operate through very great leverage and the additional pressure more than compensates for the smaller coefficient of friction. Another advantage is that the brake-shoe fits the drum, bearing upon the drum evenly, and does not become lumpy as does soft woven brake-lining under too heavy pressure.

In reply to questions asked during the discussion of the paper, it was said by Mr. Gerrard that a brake-lining cannot be made which will eliminate all the troubles with brakes that are caused by wet weather. The difficulties experienced in this respect depend largely upon how greatly a brake-lining is affected by water. Trouble is caused if brake-lining swells too much and if it shrinks too much. The cost of the brake-shoe already described was said to be from 20 to 30 per cent higher than the cost of good woven brake-lining. Experiments are now being conducted by the company to modify the method used in manufacturing the brake-shoe so that the asbestos product may become suitable for use with brakes having flexible bands. For each type of brake-drum for which the company manufactures brake-shoes, a mold is made from the original master-drum. Brake-squeaks are not eliminated by the asbestos brake-shoe unless the brake-shoe and the brake-drum have no high spots and the brake adjustment is correct.

Steering Systems

A complete steering-system consists of four major parts; the steering-gear, the drag-link or steering-gear connecting-rod, the two steering-knuckles, and the steering-knuckle tie-rod, said H. S. Watson, vice-president of A. H. Coates & Co., San Francisco. Although these four parts steer a motor-vehicle, numerous other factors enter to control the way in which the vehicle steers such as its weight, the distribution of its weight, the inclination of the front axle, the set of the front wheels, the shape of the front springs, the design and location of the pivotal points of connection between the steering-gear arm and the steering-knuckle arm,

and other features. Many troubles can and do occur beyond the steering-gear itself. If it is in the steering-linkage connected to the axle, or the front wheels, the trouble usually is blamed upon the steering-gear. Wheel wabble and wheel shimmy are examples. These are not caused by the steering-gear, and they can be controlled by the steering-gear only in very small degree. They are caused by faulty design of the steering system and depend upon the location and inclination of the front axle, the design and the inclination of the front springs, the design and position of the steering-gear connecting-rod and in the degree of tightness or looseness of the entire steering-system. In other words wabble and shimmy are due to the condition of wear or, to the tightness or looseness of the steering-knuckles, the steering-knuckle tie-rod, the steering-gear connecting-rod or its parts, the steering-gear bracket, and everything right up to, but not into, the steering-gear itself.

Mr. Watson said further that the steering-gear itself really is only a mechanism intended to transmit impulses from the brain of the driver to the steering-arm, and it should transmit the driver's brain impulses in a manner causing minimum effort and inspiring maximum confidence in the mechanism. A steering-gear must meet five requirements to accomplish such results; it must (*a*) turn easily, (*b*) require not more than two and one-half to three turns to swing the wheels from one extreme position to the other, (*c*) practically eliminate road-shock and backlash, (*d*) straighten-out with practically no effort on the driver's part after rounding a turn, and (*e*) be nearly but not entirely irreversible. Almost any type of steering-gear can be designed to perform any one of these functions well, but for a driver to attain maximum safety and maximum comfort the steering-gear should perform all of them.

Stating that about 52 per cent of the steering-gears now used are of the cam-and-lever type, Mr. Watson went on to say that it consists of a screw-type cam having a flattened angle in the center and a steeper angle at each end. Into this cam is set a stud on the end of a lever which is integral with a cross-shaft of a gear. The steering-gear arm is assembled on the outer end of the cross-shaft. Rotation of the cam moves the lever up or down and so rotates the cross-shaft. The outer end of the cross-shaft carries the steering-gear arm or steering-lever and, as the cross-shaft is rotated, the steering-lever is moved to the front for left-hand turns and to the rear for right-hand turns. After specifying some of the advantages of this type of steering-gear, the speaker said that any steering-gear built according to the general principle that 90 per cent or more of the driving is done in the center position and that faster action is needed toward either the right or the left extreme positions will provide light, easy steering, small wheel-pull, and almost negligible road-shock. Ease of steering and surer control result in greater safety because the driver has confidence in the steering-gear.

Permanent Paving in Cities

Speaking on the subject of Permanent Paving and Its Relation to Economic Automotive Transportation in Cities A. J. Eddy, city engineer, Berkeley, Cal., first reviewed the history of highway development, discussed hard-surfaced pavements and then said that the economics of transportation is a two-phase problem and that it is very difficult to correlate the two phases. It consists of economics that benefit the highway and economics that benefit the vehicle. The necessary data are very difficult to obtain.

Citing an instance in Berkeley of economic conditions beneficial to the highway, Mr. Eddy mentioned one oil-macadam pavement that has cost the city $1,645 per mile per year for the 2-year period ended June 30, 1926; while another hard-surfaced pavement having an 8-in. concrete base surfaced with asphalt cost only $53 per mile per year for the same period, that is, slightly over 3 per cent as much for maintenance. Instances cited that are beneficial to the vehicle relate to highway conditions in North Carolina as reported by B. C. Forbes. For the year from July, 1920, to July, 1921, there were 142,000 automobiles that used 73,997,000 gal. of gasoline, or 521 gal. per car. The following year a large amount of highway paving was done. For the year from July, 1922, to July, 1923, there were 247,612 automobiles that used 112,365,000 gal. of gasoline, or 454 gal. per car. During the second period, the fuel consumption was 67 gal. per car less, a saving of $16.75 per car for the cars in operation during the 1922 to 1923 period, gasoline being 25 cents per gal. These statistics were quoted by Mr. Eddy to illustrate the value of good hard-surfaced highways on which to operate motor-vehicles.

Quoting further from Mr. Eddy's address, it was estimated by Col. H. C. Boynton, for some time connected with the Portland Cement Association of the United States, that an automobile owner would save 2.6 cents per mile by driving over hard-surfaced pavements rather than over dirt roads. Records of a dealer in Springfield, Ill., who operated a drive-yourself service and who separated his cars so that some were operated almost wholly on concrete roads or hard-surfaced pavements and some likewise on country roads showed that the average saving was 2.4 cents per mile on the hard-surfaced pavement as compared with dirt roads. The speaker further supposed an average saving to an automobile owner of 2.5 cents per mile if he can drive his car altogether on concrete roads rather than on dirt roads or on oil-macadam roads and that the owner drives 5000 miles per year. The saving would be in excess of $125 per year. He advocated a campaign of education so that the public will know that the cost for upkeep and repair of oil-macadam and dirt roads is about 2.5 cents per mile for automobiles and that it may be as much as 5.0 cents per mile for trucks, although he had no data for trucks. Points brought out in the discussion following Mr. Eddy's address related to methods of paving and repaving in Berkeley.

MISPRINTS IN STUDENTS' MEETING PAPERS

In the paper by President J. H. Hunt, of the Society, delivered at the Engineering Students' Meeting of the Metropolitan Section on Feb. 16, 1927, and printed in the May issue of The Journal, the organization chart on p. 591, designated Fig. 1, and that on p. 593, designated Fig. 3, were inadvertently transposed in make-up. The description beneath the first chart applies to the chart indicated as Fig. 3, and vice versa.

In the paper by David Beecroft, in the first column on p. 591, referring to the Federal road-system, the statement is made that "Our Federal Government has appropriated $54,000,000 for the construction of this system." This probably is a mistake in the stenographic report of the meeting.

Statistics given in *Public Roads*, issued by the Department of Agriculture, show that Federal-aid paid-for highway projects, completed to the end of 1926, aggregated $446,019,421; that for projects under construction for the fiscal year July 1, 1926, to June 30, 1927, the Federal Government had allotted $151,489,782, and that additional Federal aid amounting to $13,920,561 had been allotted for work on other projects approved up to Dec. 31, 1926. These expenditures and allotments left available for new projects a Federal aid balance of $113,070,233, making the grand total of allotments and actual payments $744,493,997.

Standards Committee Meeting

THE regular Standards Committee meeting was held at French Lick Springs, Ind., on May 25 and was attended by 51 members and guests to consider and pass on the reports of the Ball and Roller Bearings, Electrical Equipment, Iron and Steel, Motorcoach, Parts and Fittings, and Production Divisions, the reports having been printed in the May issue of THE JOURNAL. In opening the meeting, Vice-Chairman Manly stated that the reports had been prepared with considerable care and that any suggestions for changes in them should typify general practice rather than specific individual applications. He also stated that after the Standards Committee has acted on the various reports they will be passed on by the Council and the general business session for submission to final letter-ballot of the Society, following which the reports approved will be published in the September issue of the S.A.E. HANDBOOK.

The reports were approved as presented, with a few exceptions which are given below. The reference following each subject indicates the status of the report and the page of the May issue of THE JOURNAL on which it was printed.

CHANGES IN REPORTS

In the report of the Electrical Equipment Division on the 7-mm. distributor nipple the inside diameters 17/64 and 9/16 in. were made maximum to insure a tight fit around the wire. In the report on Ground Return Wiring Systems, in the last line of the paragraph on Grounding, p. 552 of THE JOURNAL, the word "preferably" was omitted as it was felt that tinning the grounding connection on the frame is good engineering practice and as such should be specified in the S.A.E. HANDBOOK.

The report of the Motorcoach Division was too late for publication in the May issue of THE JOURNAL, but was circularized by letter and almost unanimously approved by the Motorcoach, Motor-Truck and Passenger-Car Divisions.

TURNING RADIUS

The turning radius of an automotive vehicle is the radius of the arc described by the center of the track made by the outside front wheel of the vehicle when making its shortest turn.

In presenting the report of the Ball and Roller Bearing Division, Chairman Brunner stated that it was desired to include the following bearings in addition to those in the printed report. These were approved subject to confirmation by the Division, the dimensions referred to being indicated on p. C31c of the March 1927 S.A.E. HANDBOOK.

Bearing No.	Bore	Outside Diameter	Height	Corner Radius Cone	Corner Radius Cup
740- 742	3.1875	5.9090	1¾	13/64	1/8
748S- 742	3.0000	5.9090	1¾	9/64	1/8
837- 832	3.0000	6.6250	2⅛	1/32	1/8
2559- 2523	1.1875	2.7500	15/16	1/32	1/16
2691- 2631	1.1562	2.6150	15/16	1/32	1/32
3188- 3120	1.2500	2.8593	1 3/16	1/16	1/8
6464- 6420	2.5575	5.8750	2⅛	9/64	1/8
14132-14274	1.3125	2.7170	25/32	9/64	1/8
14137-14274	1.3750	2.7170	25/32	1/16	1/8

The following were also approved. In Bearing No. 2786-2720, the cone radius was changed from 1/32 to 1/8 in.; Bearing No. 14118-14283, the height was changed from 27/32 to 0.8810 in.; Bearings Nos. 78216-78551 and 78251-78551, the height was changed from 2.5680 to 2.6020 in.

REPORTS APPROVED

The reports as approved are as follows, the reference following each subject indicating the status of the report and the page of the May issue of THE JOURNAL on which it was printed.

BALL AND ROLLER BEARINGS DIVISION

ROLLER BEARINGS

(Proposed Revision of Present S.A.E. Standard, p. 564)

ELECTRICAL EQUIPMENT DIVISION

DISTRIBUROR NIPPLE

(Proposed S.A.E. Recommended Practice, p. 551)

THE DISCUSSION

C. S. CRAWFORD:—I have found that we cannot assemble these nipples on our distributors due to the fact that we use a 16-point head, and the distance between the nipples is such that we cannot get the ⅞-in. diameter ring over the head. As far as I know there are only two companies using a 16-point head, but it is used frequently in aviation and I believe that it is coming into practice rather rapidly even on the cheapest grade of cars. I should like to see the lower portion of the nipple made perfectly straight and of a compound in the bottom which would permit of eliminating the bead so that the nipple could be used on all kinds of heads.

F. H. PRESCOTT:—We made a nipple for a magneto about 5 or 6 years ago which was straight-sided as Mr. Crawford suggests, that was entirely satisfactory. I do not know that there is any particular reason for putting the bead around the bottom of the nipple except that it seems to give a little more holding power.

I would suggest that we make the nipple on the 16-point head special to suit the design of the head. The difference in cost is not going to be very great on account of the small tool cost.

As it stands now everybody who is using the nipples is using practically this design and the molds are all set to give us the production that we require. Any change would mean that we would still have this nipple in production because of the mold situation.

A. J. SCAIFE:—It seems to me that this is not so serious and I see no harm in going ahead with this report inasmuch as this nipple is used in practically 99 per cent of the business.

SIDNEY DRESSER:—One point that I want to mention in connection with this nipple is that an inside negative tolerance might be added to coincide with the minus tolerance on the 7-mm. cable that is standard. The function of the nipple is to keep moisture out. Without a tolerance it is apt to make so loose a fit around the wire that the whole purpose of the nipple is defeated.

CHAIRMAN CHARLES M. MANLY:—Is there any suggestion as to what tolerance should be provided?

MR. CRAWFORD:—I understand that it could be 0.010 to 0.015 in. under the low limit of the cable.

B. M. SMARR:—When we started to develop this nipple, we did not take the distributor head into consideration at all. We considered only the nominal dimensions. We found that the rubber molds made to those dimensions run small and that the nipples do fit very tight. We are using today probably 1,000,000 a month and find this specification entirely satisfactory. If bead is taken off the bottom of the nipple a better grade of rubber compound will have to be used and we really do not think that is necessary.

R. S. BURNETT:—Would not the need for a tolerance on these dimensions be met by making the 17/64 and the 9/16-in. diameters maximum?

MR. SMARR:—That would be perfectly all right.

Ground Return Wiring Systems

(*Proposed Revision of Present S.A.E. Recommended Practice, p. 552*)

THE DISCUSSION

MR. CRAWFORD:—I think the word "preferably" should be deleted from the last sentence under the paragraph on Grounding, making it read—

> The surfaces on which the terminals make contact should be clean and free from oxide or paint, and tinned.

I think as an engineering society we should recommend a definite practice that we know is good.

MR. BURNETT:—That point was discussed in the Subdivision meetings. Some thought it should be specified as it is, while others felt that a perfectly satisfactory job could be had without the "tinned" specification.

MR. CRAWFORD:—If somebody does not want to use tinning, that is his responsibility. As a matter of record in the Society we should recommend the best because we know the trouble we have with these connections when we do not tin them.

Passenger Car Body Lighting Switches

(*Proposed S.A.E. Recommended Practice, p. 553*)

Instrument Mountings and Connections

(*Proposed Revisions of Present S.A.E. Standard, p. 553*)

Dome Light Lamp Sockets

(*Proposed S.A.E. Recommended Practice, p. 554*)

IRON AND STEEL DIVISION

Heat-Treatment Definitions

(*Proposed General Information, p. 554*)

S.A.E. Steel 4615

(*Proposed Revision of Present S.A.E. Standard, p. 555*)

S.A.E. Steel 1046

(*Proposed Cancellation S.A.E. Standard, p. 555*)

Universal Numbering of Steels

(*Sectional Committee Report, p. 555*)

S.A.E. Steels 3415, 3435 and 3450

(*Proposed Revision of Present S.A.E. Standard, p. 556*)

S.A.E. Steel 2512

(*Proposed Revision of Present S.A.E. Standard, p. 557*)

MOTORCOACH DIVISION

Turning Radius

(*Proposed S.A.E. Recommended Practice, see June issue of* THE JOURNAL, *p. 799*)

PARTS AND FITTINGS DIVISION

Oilless Bushings

(*Proposed Cancellation of S.A.E. Recommended Practice, p. 557*)

Passenger-Car Bumper Mounting

(*Proposed Revision of Present S.A.E. Standard, p. 557*)

THE DISCUSSION

HERBERT JANDUS:—In regard to the height of the rear bumper, this proposal was chosen because during the greater part of the time most cars are not driven under full load. Conditions are exceptional when they are driven continuously under full load for a long time. Furthermore, the use of bumpers is most greatly appreciated under parking conditions when there is no load in the car. Consequently, we believe that there should not be too great a difference in height between the front and rear.

J. W. SAFFOLD:—I think Mr. Jandus's remarks are very much to the point and well taken with regard to the rear bumper, but I would not be in favor of lowering the front bumpers at all. I would suggest that the front be 20 in. and the rear be certainly not any less than that.

CHAIRMAN MANLY:—Do you propose to make that as a motion for an amendment to this recommendation? We want to give you every opportunity to bring out whether or not the rest of the Committee here view the matter in the same light you do or in the light in which the Division has made its report.

MR. SAFFOLD:—I so move, that the report be amended to have the front bumper 20 in. high.

M. C. HORINE:—As I understand the reason for wanting to lower bumpers, it is that frames on passenger cars are being made lower and it is desired to get the center line of the bumper approximately in the plane of the frame. Has consideration been given to the fact that passenger cars are not the only vehicles on which bumpers are used? This standard as proposed was a passenger-car standard. What is to be done on motorcoaches and trucks? Their bumpers are considerably higher than the proposed standards, higher even than the present height of the average run of passenger-car frames. Unless bumpers are positioned so that they can give some protection against or or to motorcoaches and trucks, you have not fulfilled the requirements.

CHAIRMAN MANLY:—This is a recommendation for use on passenger cars, and has no relation to bumpers on motorcoaches as such, or on trucks as such.

MR. HORINE:—That is just the point. If we propose to establish a passenger-car standard independently of motorcoaches and trucks and hope that the truck and motorcoach builders will bring their bumpers down to that height, we have to consider the truck and the motorcoach at the outset, owing to the desirability of getting the bumper thrust somewhere in line with the frame. This feature is more important on heavy vehicles than on light vehicles.

MR. CRAWFORD:—The report states definitely:

> Protective bumpers for passenger cars, small motorcoaches and light delivery trucks.

I do not see how it would be possible to have a standard that is applicable for large motorcoaches and trucks as well as passenger cars.

MR. SCAIFE:—I think that possibly this suggestion was taken as an amendment due to the fact that nearly all the motorcoach and passenger-car frames are around 20 in. It might be possible to work out a combination whereby the top height of the bumper, either front or rear, would be higher than the lowest measurement on a motorcoach or a truck. I think it is being put too low for a question of looks rather than a question of protection.

MR. SAFFOLD:—Mr. Jandus's remark about the machines being not under load when they are parked is very well taken. The height of about 21 in. on the rear bumper is responsible for a large amount of the telescoping. The extreme height of front bumpers at their vertical center point is 20 in.; many of them are a little less than that. That causes the telescoping. I am in favor of lowering the rear bumper heights to meet that of the front bumpers, but I am not in favor of lowering the front bumpers to make the conditions worse.

MR. JANDUS:—I think possibly Mr. Saffold does not take into account the fact that the tolerances given in the report will meet that variation. A difference of 1 in. between front and rear bumpers is not at all serious. The cause of hooking has been due to the fact that the bumper standards have not been adhered to. If they had been adhered to there would be no question about the two bumper faces meeting.

A. J. UNDERWOOD:—The main criticism of the present specifications has been that they do not meet present conditions or demands. This recommendation was worked out to meet the new car designs, and for protection. The tolerance given on the width of bumper face allows enough for safe overlapping for protection.

W. C. KEYS:—I think the records of the meetings held on this subject will show that this report on bumper height was favored unanimously by the Subdivision and also by the Parts and Fittings Division. We had representative bumper

manufacturers and also several car builders present and this subject was very thoroughly discussed, and this recommendation approved unanimously.

CHAIRMAN MANLY:—This motion is only directed to changing the Division's recommendation on the height of the front bumper from 18 to 20 in. or what is now the standard.

W. A. STARCK:—The present height of 18 in. is governed, to a great extent, by the method of attaching the bumper. Passenger cars are built lower than they used to be, and we still maintain the same attaching specifications, defeating the purpose by putting them higher. If we are going to lower the attaching member 2 in., or raise the bumper 2 in. higher, we are defeating the purpose of the bumper.

[On being put to a vote, the motion to amend the Division's recommendation from 18 in. to 20 in. was lost.]

CHAIRMAN MANLY:—We now come back to the report of the Division as presented. Have you any further remarks you wish to make on that?

MR. JANDUS:—Only this, that the height specification was made with due regard to appearance as well as effectiveness. The lower cars really require lower bumpers from the standpoint of appearance and there is no doubt that car builders would not follow the old standard because bumpers do not look good at that height.

W. R. STRICKLAND:—I move the acceptance of the report, to be transmitted to the Council, with information of the discussion here this afternoon so they may be governed accordingly.

MR. SCAIFE:—I think we always get into trouble where we try to have a standard precede general practice instead of following such practice. I should like to raise the question, is 18 in. now the general practice? If not, it ought not to be a standard, but it might be recommended practice.

MR. JANDUS:—The general practice is tending toward the 18-in. bumper height on all the new cars with the low chassis.

MR. CRAWFORD:—I think the biggest trouble with this whole proposition is the fact that most of the car engineers have had very little regard for past recommendations. If we can agree on a standard, whatever it may be, it will be all right; if we will all use it.

CHAIRMAN MANLY:—Are you ready to vote?

[The motion to adopt the report as printed was carried.]

FLEXIBLE DISKS

(Proposed Revision of Present S. A. E. Recommended Practice, p. 557)

SMALL RIVETS

(Proposed Revision of Sectional Committee Report, p. 557)

SPLIT AND TUBULAR RIVETS

(Proposed S. A. E. Recommended Practice, p. 558)

PRODUCTION DIVISION

CUT AND GROUND TAPS

(Proposed S. A. E. Standard, p. 559)

The action of the Standards Committee was reported to the Council and to the General Business Meeting of the Society in the evening and ordered to letter ballot of the Society members for final action and publication in the September, 1927, issue of the S. A. E. HANDBOOK.

S. A. E. STANDARDIZATION POLICY

President J. H. Hunt and Standards Committee Vice-Chairman C. M. Manly reviewed the work of the Standardization Policy Committee and presented the following report of the committee for the information of the members of the Society.

The purpose of the Standardization Policy Committee is to define the general Policy of the Society's standardization activities and to act in an advisory capacity with the Divisions of the Standards Committee on subjects involving questions of policy.

Specifications may be standardized to

(1) Promote interchangeability of parts and units
(2) Eliminate unnecessary variety of parts and materials
(3) Facilitate production and maintenance
(4) Promote uniform methods of testing
(5) Establish nomenclature and standardize tests of performance or operation
(6) Set up standards or codes for promotion of safety

Standardization of specifications shall not place unnecessary limitations or restrictions on individuality of design, construction, performance or operation.

Specifications shall not be standardized unless there is sufficient desire for such standards expressed by the industries affected.

The fact that patents or protective rights may relate to a device, material or process does not preclude setting up specifications for such subjects. Where a patent right is known to be involved in standardizing a specification, the subject should be referred to the Patents Committee for consideration and recommendation as to procedure.

ATTENDANCE AT STANDARDS COMMITTEE MEETING

The members of the Standards Committee and the Society members and guests in attendance were:

Standards Committee Members

W. J. Baumgartner	C. M. Larson
C. E. Bonnett	C. M. Manly
A. Boor	E. S. Marks
G. R. Bott	L. F. Maurer
H. E. Brunner	S. W. Mills
R. S. Burnett	F. H. Prescott
L. A. Chaminade	A. J. Scaife
J. D. Cutter	B. M. Smarr
A. W. Herrington	C. W. Spicer
M. C. Horine	W. R. Strickland
H. S. Jandus	A. J. Underwood
W. C. Keys	George Walther

T. H. Wickenden

Society Members and Guests

C. E. Banta	E. A. Kelly
David Beecroft	G. L. Kyle
L. A. Bixby	R. P. Lay
F. G. Brewer	H. W. Linkert
G. A. Burn	R. E. Plimpton
S. R. Castor	N. B. Pope
D. S. Cole	W. H. Ragsdale
Charles Cotta	J. W. Saffold
C. S. Crawford	H. J. Stagg
E. B. Denison	W. A. Starck
S. R. Dresser	C. S. Whitney
Dean Gillespie	G. W. Yanss
P. M. Heldt	

AUTOMOTIVE RESEARCH

(Concluded from p. 692)

the like. The determining factor, however, is the need for adequate illumination on the road in rounding turns. Because of the angle at which the beams are directed to the road, considerably less angular-width is necessary at the top of the beam than at the bottom to illuminate the same width of roadbed

The above are some of the rough limitations on intensity and distribution. Obviously, however, the ideal distribution for a straight level road is quite different from that for a rolling or hilly road, and neither of these would be best for a winding road. In determining the best all-round distribution, observers must keep in mind all of these variables and endeavor to make their observations representative.

MAY COUNCIL MEETINGS

A SESSION of the Council was held in Detroit on May 5, those attending being President Hunt; First Vice-President Wall; Councilors Chandler, Sparrow, Wooler, and Veal; and Chairman Herrmann of the Standards Committee.

The following subjects were assigned to Divisions of the Standards Committee respectively as indicated below:

- Propeller-Hubs—Aeronautic Division
- Tire and Rim Dimensions for Airplanes—Aeronautic Division
- Airplane Storage-Batteries—Electrical Equipment Division
- Ferrules and Junction Boxes—Electrical Equipment Division
- Duplex-Carbureter Mountings—Engine Division
- Sectional Committee Report on Numbering of Steels—Iron and Steel Division
- Engine Distillate—Lubricants Division
- Turning-Radius of Motor-Vehicles—Motorcoach Division
- Split Bushings and Spacer Tubes—Parts and Fittings Division
- Windshield-Cleaner Mounting—Parts and Fittings Division
- Window-Glass Channels—Passenger-Car Division
- High-Sulphur, High-Manganese Steel (chemical composition and probably physical characteristics)—Production Division
- Taps for Machine-Screws Cut and Ground Threads, Hand Plug Taps Ground and Cut Threads, Tapper Taps Ground and Cut Threads—Production Division

The following Standards Committee appointments, with assignment to the Divisions specified, were made:

- A. K. Brumbaugh—Electrical Equipment and the Parts and Fittings Divisions
- H. T. Chandler—Iron and Steel Division
- M. J. Hager—Motorboat Division
- D. W. Ovaitt—Production Division
- E. A. Portz—Iron and Steel Division
- D. F. Shields—Lubricants Division
- W. F. Thoms—Lighting Division

The Council accepted the recommendation of the Production Division and the Production Advisory Committee that the production standards of the Society be printed on 8½ x 11-in. sheets for use in loose-leaf binders.

D. W. Ovaitt was named to succeed W. J. Outcalt as a representative of the Society on the Sectional Committee on Plain Limit-Gages.

The following were requested to represent the automotive industry on the American Society for Testing Materials Committee D-2 on Rubber Products:

S. R. Castor	H. H. Franklin Mfg. Co.
L. C. Conrad	Spicer Mfg. Corporation
W. H. Graves	Packard Motor Car Co.
H. L. Greene	Willys-Overland Co.
W. F. Klein	General Motors Truck Corporation
A. F. Masury	International Motor Co.
B. M. Smarr	General Motors Corporation
A. W. Subberra	Studebaker Corporation of America
Charles P. Thomas	Reo Motor Car Co.

The meeting of the Council held at French Lick Springs, Ind., during the Summer Meeting was attended by President Hunt; First Vice-President Wall; and Councilors Milton, Sparrow, Veal, Winchester, and Wooler.

In the matter of the Society cooperating in the conduct of the awarding from time to time of medals, to be known as the Daniel Guggenheim Medal, to persons in recognition of notable achievement tending to the advancement of aeronautics, the members of the Society who during the last several years have been its Second Vice-Presidents representing Aviation Engineering were named as the spokesmen of the Society. Details of the organization unit will be announced in due course.

At the May Council meetings, 258 applications for individual membership were approved and confirmed. The resignations of 14 members were accepted. Fifteen reinstatements to membership were granted. Nineteen transfers in grade of membership were made.

The financial statement and the committee reports considered and approved by the Council at its meeting held on May 25 are set forth in substance elsewhere in this issue of THE JOURNAL. In this account financial figures as of April 30 will be found. The financial statement as of March 31 showed a net balance of assets over liabilities of $193,-725.15, this being $39,317.82 more than the corresponding figure on the same day of 1926. The net revenue of the Society for the first 6 months of the current fiscal year amounted to $193,875.48. The operating expense during the same period was $174,951.48. The income for the month of March was $37,753.29, and the operating expense $34,086.51.

LATIN-AMERICAN TRADE

LATIN-AMERICAN countries sold to the United States about $200,000,000 more goods last year than this Country sold them. This apparent adverse trade balance is, of course, offset to a great extent by large American investments and by other invisible exports. American imports from all of the Latin-American countries increased 3½ per cent in 1926, reaching $1,044,884,000, as compared with $1,009,188,000 in 1925. American exports on the other hand, declined about 1 per cent, decreasing from $882,000,000 in 1925 to $872,800,000 in 1926.

The United States increased its purchases from the South American mainland last year by $50,000,000, or 9½ per cent. This was the largest relative increase of any continent in our import trade. The total value of our imports from South American countries last year amounted to $567,978,000, as against $518,991,000 in 1925. It is noteworthy that, with the exception of sugar, more than 80 per cent of the total imports of the United States from the Southern Hemisphere enter the Country free of all duty.

Europe, which normally receives about half of our exports, last year took goods to the value of $2,309,706,000 or $294,044,000 less than in the preceding year. This loss may be attributed almost entirely to the decreased value of cotton exports. In most other lines, exports to Europe show a small gain. The decline in total shipments is rather evenly distributed among the various countries. Imports from Europe into the United States varied from those of the preceding year by only $48,000,000, the totals for 1926 and 1925 being $1,285,870,000 and $1,238,181,000 respectively.—*Guaranty Survey.*

THE 1927 SUMMER MEETING

(*Continued from p. 708*)

Eberhard Mfg. Co.
Eclipse Machine Co.
Edison Lamp Works of General Electric Co.
Egyptian Lacquer Mfg. Co.
Electric Auto-Lite Co.
Electric Storage Battery Co.
Ethyl Gasoline Corporation
Fafnir Bearing Co.
Fairchild Aviation Corporation
Fairchild Caminez Engine Corporation
Fay, Inc., Thomas J.
Federal-Mogul Corporation
Federal Motor Truck Co.
Firestone Steel Products Co.
Firestone Tire & Rubber Co.
Fisk Rubber Co., Inc.
Flintlock Corporation
Four Wheel Drive Auto Co.
G. & O. Mfg. Co.
Gabriel Snubber Mfg. Co.
Ganschow Co., William
Gardner Advertising Co.
General Motors Corporation
General Tire & Rubber Co.
Gerlach-Barklow Co.
Glidden Co.
Goodlin Automotive Equipment Co.
Goodyear Tire & Rubber Co.
Guggenheim Fund for the Promotion of Aeronautics, Inc., Daniel
Guide Motor Lamp Mfg. Co.
Gwisdalla Carburetor Corporation
H. A. D. Sales & Engine Co.
Halcomb Steel Co.
Hall Lamp Co., C. M.
Handy Governor Corporation
Harley-Davidson Motor Co.
Harris Electric Co.
Harrison Radiator Corporation
Hayes Ionia Co.
Hayes Wheel Co.
Henney & Co., John W.
Hercules Motors Corporation
Herron - Zimmers Moulding Co.
Hershey Mfg. Co.
Hill Products Corporation
Holley Carburetor Co.
Hoopes Bros. & Darlington
Hyatt Roller Bearing Co.
Hydraulic Brake Co.
Illinois Steel Co.
International Harvester Co.
International Nickel Co.
Interstate Iron & Steel Co.
Irvington Varnish & Insulator Co.
Jaeger Watch Co., Inc.
Jamestown Metal Equipment Co.
Johnson Bronze Co.
Jones & Laughlin Steel Corporation
Jordan Motor Car Co.
Kelso Co., Inc., Charles M.
Kerite Insulated Wire & Cable Co., Inc.
Kingsley, Dave P.
Kirk-Latty Division of Lamson & Sessions Co.
Koolfast Radiator Co.
Lamson & Sessions Co.
Lang Body Co.
Larrabee-Deyo Motor Truck Co., Inc.
Leeds & Northrup Co.
Link-Belt Co.
Long Mfg. Co.
Madison-Kipp Corporation
Manhattan Rubber Mfg. Co.
Manley Mfg. Co.
Mansfield Sheet & Tin Plate Co.
Martin-Parry Corporation
Mathews Steel Castings, Inc.
McCord Radiator & Mfg. Co.
Mechanics Machine Co.
Mengel Body Co.
Minneapolis Threshing Machine Co.
Mitchell Specialty Co.
Monogram Lens Corporation
Monroe Calculating Machine Co.
Morse Chain Co.
Moto Meter Co., Inc.
Motor & Accessory Manufacturers Association
Motor Equipment Co.
Motor Products Corporation
Motor Wheel Corporation.
Mountain Varnish & Color Works, Inc.
Murphy Varnish Co.
Nagel Electric Co., W. G.
National Carbon Co., Inc.
National Lamp Works of General Electric Co.
National Malleable & Steel Castings Co.
National Refining Co.
National Screw & Mfg Co.
National Tube Co.
New Departure Mfg. Co.
New England Transportation Co.
Norma - Hoffmann Bearings Corporation
North East Electric Co.
Norton Co.
Noyes-Buick Co.
O. & S. Bearing Co.
Oakland Motor Car Co.
Packard Electric Co.
Packard Motor Car Co.
Paige-Detroit Motor Car Co.
Peerless Motor Car Corporation.
Penberthy Injector Co.
Pennjersey Rapid Transit Co.
Pennsylvania Railroad Co.
Peoples Rapid Transit Co.
Perfect Circle Co.
Philadelphia Rural Transit Co.
Pierce-Arrow Motor Car Co.
Pioneer Instrument Co.
Piston Ring Co.
Pittsburgh Plate Glass Co.
Pratt & Whitney Aircraft Co.
Prest-O-Lite Co., Inc.
Pure Oil Co.
Rajah Co.
Republic Motor Truck Co., Inc.
Reynolds Spring Co.
Rich Tool Co.
Roberts Brass Mfg. Co.
Rockford Drilling Machine Co.
Ross Gear & Tool Co.
S. K. F. Industries, Inc.
Sauzedde Corporation
Schacht Motor Truck Co., G. A.
Scintilla Magneto Co., Inc.
Selker Brass Mfg. Co.
Service Products Corporation
Shore Instrument & Mfg. Co.
Shuler Axle Co., Inc.
Simplex Piston Ring Co. of America
Sinclair Refining Co.
Spicer Mfg. Corporation
Standard Oil Co. of New Jersey
Standard Oil Co. of New York
Standard Steel & Bearings, Inc.
Standard Steel Spring Co.
Sterling Engine Co.
Sterling Mfg. Co.
Stewart-Warner Speedometer Corporation
Stover Signal Engineering Co.
Stutz Motor Car Co. of America
Texas Co.
Textile Fabrics Corporation
Thermoid Rubber Co.
Thompson Products, Inc.
Tiffany Corporation, D. H.
Tillotson Mfg. Co.
Timken-Detroit Axle Co.
Timken Roller Bearing Co.
Titeflex Metal Hose Co.
Toledo Scale Co.
Toledo Steel Products Co.
Union Drawn Steel Co.
Union Oil Co. of California
United Railways & Electric Co.
United States Asbestos Co.
United States Chain & Forging Co.
U. S. Light & Heat Corporation
United States Rubber Co.
Vacuum Oil Co.
Van Dorn Electric Tool Co.
Vlchek Tool Co.
Wallace Barnes Co.
Warner Gear Co.
Watson Co., John Warren
Westinghouse Air Brake Co.
Westinghouse Union Battery Co.
Whitney Blake Co.
Whitney Mfg. Co.
Willard Storage Battery Co.
Wire Wheel Corporation of America
Wisconsin Parts Co.
Witherow Steel Co.
Wolverine Bumper & Specialty Co.
Wood Hydraulic Hoist & Body Co.
Wood, Inc., Gar.
Wyman-Gordon Co.
Yellow Truck & Coach Mfg. Co.
Youngstown Sheet & Tube Co.
Zenith-Detroit Corporation

The Summer Meeting Technical Sessions

Details of the Papers, Demonstrations and Discussions on a Wide Variety of Topics

Topics of interest to everyone were covered by papers presented at the technical sessions. They included physics, mechanics, chemistry, illumination, research, design, service, body finish, economics, and legislation and ranged from the minutiæ of atomic structure to the magnitude of China and the industrial and commercial possibilities that her awakening will present.

All matter is composed of atoms, and atoms are nothing but electrical charges, or energy; that is, nuclei of positive charges that attract from 1 to 88 electrons of negative charge that fly around the nuclei in circular and elliptical orbits millions upon millions of times per second. Even in the densest metals the structure of the atoms is so open that it can be penetrated by very short light rays. The whole scheme of the atom was demonstrated with a model assembled from rings and ellipses each of which carried a red ball representing an electron.

China was depicted as undergoing a whole series of revolutions at once and faced with the combined problems of Washington and Lincoln. She is struggling to throw off an autocratic form of government of 5000 years' standing and to substitute a democratic form like that of America; to cast off foreign domination that has continued for 1000 years since the Mongols, and later the Manchus, swept down from the North; to attain national unity and sovereignty; to substitute modern mechanical industrialism for the centuries-old manual system; and to overcome the illiteracy of seven-eighths of her 400,000,000 population. China offers the greatest industrial and commercial possibilities in the world today.

That front-wheel camber and toe-in are likely to be found unnecessary and that steering-system geometry will be improved as a result of studies of front-wheel tire-tread wear was asserted by one speaker, who pictured and explained different forms of tread wear caused by positions of the front wheel that interfere with pure rolling contact of the tire with the road surface. Accurate adjusting facilities for correct toe-in, camber and steering geometry are needed.

Advantages and detailed design of internal-geared four-speed transmission were explained and illustrated by another speaker. Main advantages are high car-speed with relatively low engine-speed on direct drive, greater hill-

climbing speed on third gear, quieter car operation in third speed than in second speed with the conventional three-speed transmission, and reduced fuel-consumption.

Wet road surfaces have a material effect on the distribution of head-lamp light in night driving. When the beam is depressed the light is reflected from the wet surface and causes more glare in the eyes of approaching drivers. Under wet-road conditions, glare is greatly reduced, as shown by a number of tests, and visibility much improved by use of a non-symmetrical system in which, instead of depressing the beam, the light can be switched from straight ahead to the right side of the road where illumination is most needed when passing other cars.

Abolishing of the vertical focusing-adjustment in depressible-beam two-filament head-lamps was strongly advocated, and by demonstrations it was shown that the single horizontal adjustment suffices with incandescent lamps made to the present commercial accuracy. The vertical adjustment only complicates the task of focusing. A simple remedy suggested for all focusing problems was the use in a non-focusing head-lamp of a ring in the socket similar to the jig ring used by the lamp manufacturer for positioning the filament in the bulb.

Research was depicted as guessing, or the formulation of hypotheses, stimulated by curiosity, and the checking of the hypotheses by experimentation. Closer cooperation of the automotive industry with the universities was recommended as a step in encouraging investigations to solve in advance some of the problems of the industry.

That various kinds of hydrocarbons, such as straight-run and cracked gasolines, do not differ appreciably, aside from their volatility, in their ability to start an engine was the inference drawn from data obtained in engine-starting tests reported. Other tests on the influence of different factors on engine acceleration with a given fuel resulted in conclusions that acceleration is not affected by temperature of the cylinder-walls or location of the accelerating jet, but is largely dependent upon the temperature of the intake manifold, and that an accelerating charge ceases to improve acceleration only when the idling mixture is excessively rich.

The deplorable state of specification writing for petroleum lubricants was criticized and purchasers of lubricating oil who have not the facilities and technical knowledge to do so themselves were, by inference, advised to rely upon the oil manufacturers to determine the properties best suited for a specific service. Those who do write their own specifications and who name values of different properties were urged to specify that tests are to be made by the latest methods approved by the American Society for Testing Materials.

Centrifugal force has a major influence on oil-flow in crankshaft bearings and this influence can be controlled to a considerable extent by the radial location of the oil-hole in the crankpin, according to a report of an investigation of the subject. The effect of changes in pressure varies with difference in engine speed. Maximum pressure in a journal bearing may reach five times the average pressure. Some type of oil groove to collect dirt may be needed.

Slow-motion pictures of valve-spring surging at a very high rate in the natural vibration period of the spring revealed one of the primary causes of spring failure. When the spring's natural period is in synchronism at some point with the less-frequent forced-vibration due to valve-cam lift, excessive and reversing stresses of high value result and cause spring fracture.

How cheat-lines increase the apparent length and decrease the apparent height of cars was illustrated graphically by the making of a pastel sketch of a car while a verbal description of the principles of the optical illusion was given. Appearance and comfort were asserted to be the major factors in body designing, and the body should be built around the passengers, according to the speaker.

A type of two-shoe brake with cast-iron drum that is giving satisfactory service on motorcoaches with 20-in. drums and on 2½-ton trucks was shown in slides and described. These dissipate the braking heat rapidly, give the maximum degree of self-energizing that is usable without seizing when commercial lining is employed, and are equally effective in either direction. For use on large six-cylinder motorcoaches having four-wheel brakes, a servo-mechanism and metal-to-metal contact are employed with no friction lining. When the shoes are worn out they are thrown away.

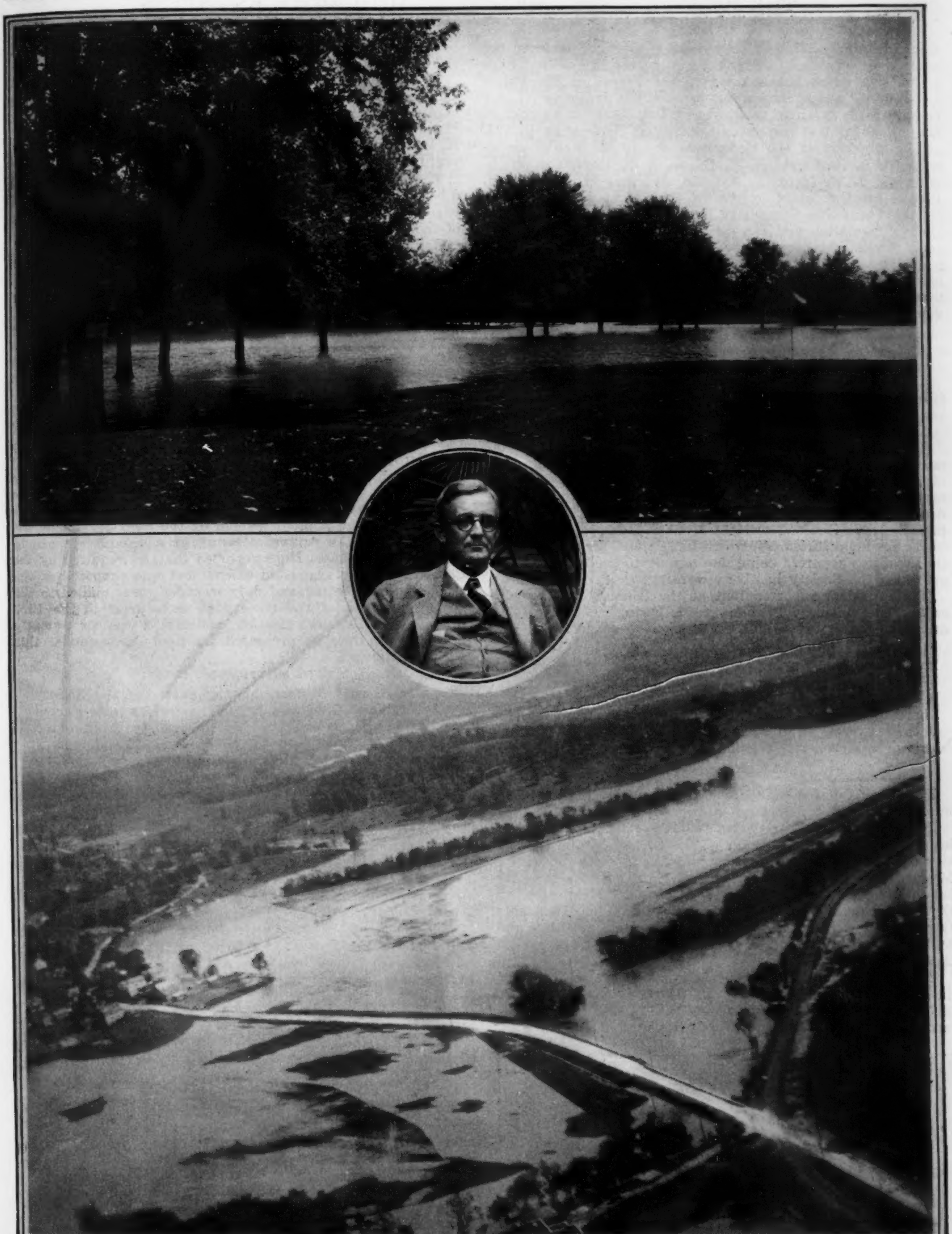
Four-wheel brakes need perfect cross equalization if they are to assure quicker and safer deceleration than two-wheel brakes, according to one speaker, who asserted that braking standards should be set up and the brakes adjusted at the factory and kept adjusted at the service station in accordance with this standard. Results of brake-lining tests by the Bureau of Standards were given in another paper.

Charles M. Manly Who Presided at Standards Committee Meeting

STANDARDS COMMITTEE MEETING

The regular meeting of the Standards Committee was held on May 25 and was attended by 51 Society and Committee members and guests. Six Divisions submitted 21 reports for approval, all of which were passed upon favorably and with only minor changes in 2 of them. Information regarding these modifications is given in the detailed report on p. 799 of the action taken by the Committee. The reports were duly approved by the Council and at the general Business Session of the Society on the same day and ordered to letter-ballot of the voting members of the Society. The ballot will be mailed to the members shortly after the appearance of this issue of The Journal and should be returned before Saturday, June 25, on which date the ballots will be counted. The recommendations thus approved will be included in the next issue of the S.A.E. Handbook, which will be ready for distribution in September.

An innovation at the Standards Committee meeting this year was the presenting of an informal report by Vice-Chairman Manly on the work of the Society's Standardization Policy Committee, of which he is chairman, and the policy that has been formulated as the result of the many years of standardization activity. The policy has been formulated on a broad basis because it is almost impossible to set down narrow governing principles in detail without interfering with the proper functioning of the Standards



FLOOD CONDITIONS AT FRENCH LICK SPRINGS

Upper View Shows Fairways for First and Eighteenth Holes of Lower Golf Course. The Lower Photograph, Showing Conditions near French Lick, Was Taken by T. J. Litle, Jr. (Insert) on His "No-Place-To-Land" Flight

Committee or making it very difficult to carry forward the work most effectively under controlling conditions that have to be taken into consideration. The report of the Policy Committee, which was approved by the majority of the committee, is given in this issue of THE JOURNAL as part of the report of the Standards Committee Meeting on p. 801.

The members of the Committee are C. M. Manly, chairman; B. B. Bachman, H. M. Crane, K. L. Herrmann, H. L. Horning, J. H. Hunt, T. J. Lítle, Jr., and F. A. Whitten. It was not the intent to present the report for any action by the Standards Committee but to lay it before them for their information and for discussion of any points relating to it that might properly be referred to the Committee for consideration. The absence of any discussion of the report indicated general approval and acceptance of it, and there was evidently a general feeling that it will be valuable to the various committees of the Society in their future work.

SEMI-ANNUAL BUSINESS MEETING

Constitutional Revision Approved for Submission by Letter-Ballot of Members

The reports of the Standards and Administrative Committees were submitted at the Semi-Annual Business Meeting of the Society, which was held on Wednesday, May 25, immediately preceding the General Session, over which President J. H. Hunt presided. These reports appear in full on p. 775 of this issue. President Hunt called special attention to the financial statement, which he felt was very gratifying, the condition reported being due largely to the budget policy on which the Society has been working.

The President reported that at the Council Meeting preceding the Business Session the following cablegram was drawn up:

> Captain Lindbergh,
> American Embassy,
> Paris.
>
> The Society of Automotive Engineers assembled here today extends to you for its 6000 members most hearty expression of our profound admiration for your heroic achievement in aviation.
>
> SOCIETY OF AUTOMOTIVE ENGINEERS

Following the Business Session, this cablegram was sent out on behalf of the Society.

President Hunt also reported that a cordial invitation had been extended to the members of the Society by the Institution of Automobile Engineers and the Society of Motor Manufacturers and Traders, both of England, to attend the International Commercial Motor-Transport Exhibition at Olympia, Nov. 17 to 26, and the World Motor Transport Congress, as well as the social and professional meetings and sessions of the two British organizations issuing the invitation.

The main object of the Congress is to discuss action along lines consistent with development of road motor-transport throughout the world. Conferences will be held on railroad-terminal services, retail-store distribution and functions of omnibuses and trams. Visits will be made to various establishments and factories.

CAPTAIN LINDBERGH'S PLANE, THE SPIRIT OF ST. LOUIS

It is thought by President Hunt that the invitation presents an unusual opportunity for Society members and he said he hoped a large number would take advantage of it. Members who are interested in making this trip should get in touch with the Society headquarters at the earliest opportunity.

The opportunity afforded members of making this trip in a body is of inestimable value, not only because of the knowledge to be gained at the exhibition and sessions, but because of the social contacts with leaders in the industry.

Regarding the proposed revision of the Constitution with respect to reorganization of the Council, President Hunt stated that at the meeting of the Council on May 5 the Constitution Committee reported that, in view of the lack of interest and of expression of opinion on the part of members in general, it felt that it could not take intelligent action at that time. It had therefore recommended that no action be taken by the Society on amending the Constitution as originally proposed by Councilor Winchester at the 1926 Annual Meeting and withdrawn by him at the 1926 Summer Meeting in view of the apparent need for further study. As the Council concurred in this view, the President stated that the Constitution Committee would give the subject further consideration.

With reference to the amendment of Section C46 of the Constitution, the purpose of which was to make it possible for the regular Nominating Committee of the Society to be organized at the Annual instead of the Semi-Annual Meeting preceding the Annual Meeting at which officers are to be elected, President Hunt reported that, as required by the Constitution, the suggested amendment was proposed at the 1927 Annual Meeting and duly seconded; was mailed to the voting members of the Society 60 days prior to the 1927 Semi-Annual Business Meeting, and that it was consequently in order for it to be presented for final discussion at this Business Session.

Section C46, revised as proposed, reads:

> The Annual Nominating Committee of the Society shall consist of one Member of the Society to be elected from and by each Section of the Society prior to the Annual Meeting; and three Members of the Society who shall be elected at the business session of the Annual Meeting preceding the Annual Meeting at which officers are to be elected; no two of said three Members shall reside in the same Section District.

On motion of F. E. Moskovics, duly seconded, the proposed amendment was approved.

In accordance with Section C46 of the Constitution, as at present in force, F. M. Germane, Walter C. Keys and S. B. Stevens, were elected as members-at-large of the Annual Nominating Committee.

The report of the Standards Committee covering the new and revised specifications approved at the Standards Committee Meeting on Wednesday afternoon, May 25, was approved as submitted by Vice-Chairman C. M. Manly.

THE ATOM AND CHINA REVEALED

Structure of Former Dissected and Chinese Situation Explained at General Session

Fascinatingly interesting and instructive are none too strong descriptive terms to apply to the extemporaneous talk and demonstration given at the General Session by Dr. E. F. Barker, of the University of Michigan, on the structure of the atom and the enthusiasm arousing discourse by Dr. C. H. Robertson on the turbulent situation in China. At the conclusion of his address Dr. Robertson was given a tribute of prolonged standing applause.

President Hunt presided over the evening session, which was well attended and which was started with a brief business meeting reported elsewhere in this issue of THE JOURNAL. As a result of the two addresses, everyone who was present must carry home from the meeting a much

clearer conception than he ever had before of how an atom is built up and with similar atoms forms elements, and the causes and probable outcome of the confusion and turmoil in China.

Dr. Barker demonstrated the theory of the structure of the atom with a small model comprised of wire rings and ellipses, each of which carried a little red ball representing an electron. These he assembled in various planes around a central white ball representing the nucleus of the atom. The science of the physical and chemical properties of matter is of very recent development, but has assumed an extraordinarily important place in modern civilization, began the speaker. Conception of the chemical element was extremely confused 150 years ago and little distinction was made between pure substances and combinations of them. During the Nineteenth Century chemistry passed through a phase that might be called the descriptive phase, beginning with the isolation of the various elements, and is not yet quite complete. We are now acquainted with 89 different elements and anticipate the discovery of 3 more whose properties can be predicted with great precision. The most recent addition to the list and the only element discovered by an American is illium, announced only a few months ago at the University of Illinois. This is No. 65 in the list.

Matter and Energy Are the Same

We are beginning now to understand that matter and energy are the same; that matter can go out of existence and reappear as energy and that energy can go out of existence and appear as matter. Hence matter is not indestructible as such and it is possible for matter to be created, yet the theory of conservation of energy holds good, but has a new significance. Conditions under which the interchange of energy and matter occurs are beyond human control, but we know how the simple elements are created. To illustrate this process Dr. Barker held up a wire hoop about 1 ft. in diameter with a red ball at one point in its orbit and said that an atom consists of electric charges: negative electrons, one of which was represented by the ball, and positive protons, which build up the nucleus. These particles are so extremely small that they never will be revealed by the most powerful microscope; if a golf ball is conceived to be magnified to a diameter of 200,000 miles its atoms will have become about 1 ft. in diameter, and the electrons that form a considerable part of the atomic structure, and the nuclei as well, will be about 0.01 in. in diameter. Even with so dense a material as copper, in which each atom has a nucleus surrounded by 29 electrons, the structure of the atom is so open that it is possible to see through it if light rays of sufficiently short wave-length, such as X-rays, are used.

The particles, or atoms, of which materials are built are nothing but positive and negative electric charges, he repeated, and are influenced by neighboring electric and magnetic fields, nothing else. If the energy of their electric and magnetic fields is dissipated by radiation, they go out of existence.

Process of Atom Building Demonstrated

Beginning with an atom of hydrogen, which is the simplest, Dr. Barber said that it is composed of a minute positive

THE CHAIRMAN AND SPEAKERS AT THE GENERAL SESSION
Dr. C. H. Robertson (Left), Who Discussed "What Is Happening in China"; Dr. E. F. Barker (Right), Who Discussed the Structure of the Atom, and President J. H. Hunt (Center), Who Presided at the General Session

particle and a single negative electron which describes a circular orbit about it millions and millions of times per second. The diameter of the orbit is on the order of 0.00000001 in. Such an atom is exceedingly active, because it has intense electric and magnetic fields, hence reacts with great violence when it comes in contact with any other kind of atom.

If the charge of the positive nucleus is doubled, it attracts two electrons and brings them closer together or toward itself, reducing their orbits. This the speaker represented by setting up such a group on the demonstration stand. The orbits of the electrons occupy intersecting planes, but these probably are not fixed; the whole system twists and turns continuously due to mutual repulsions of the negative charges. Such a group is electrically satisfied and is inactive, having little tendency to form combinations with other atoms. Helium gas belongs to this group of inert elements and is among the latest to be discovered.

Increasing the charge of the nucleus of this helium atom to three units results in further reducing the size of the orbits of the two electrons and adds a third electron, which, however, has an elliptical and much larger orbit that wanders away from the group, but penetrates within the shell of the inner structure. This wandering electron again makes the group, or atom, very active chemically. Such atoms, with three electrons, form lithium, which is monovalent and forms compounds with other monovalent substances.

A fourth increase in charge of the nucleus causes a fourth electron to be added to neutralize the electrical condition, and this electron travels in an elliptical orbit like that of the third electron but diametrically opposite it. At the same time the group of orbits as a whole grows smaller and the element composed of such atoms is denser, because of the greater charge upon the nucleus and the greater electrostatic tractions. This element is beryllium or No. 4 in the atomic scale.

Increased Positive Charge Adds Negative Electrons

As Dr. Barker proceeded with his explanation he continued adding circles and ellipses of wires, each carrying its red ball and occupying a different plane, until a complicated structure was built up. With a charge of five units, the fifth electron again takes a circular orbit but much larger than those of the two inner electrons. A sixth electron does the same, but on the opposite side of the nucleus. This kind of atom forms carbon, which has a valence of 4, attributed to the four electrons in the outer shell of the structure. The atom still has a considerable tendency to complete this outer shell by the addition of four more electrons, hence carbon atoms combine with one another in an extremely rigid manner, so that we have diamond crystals.

The nitrogen atom is formed by the addition of a seventh electron, which takes a circular but still larger orbit, and the atom again is active with a tendency to complete the outer shell by the addition of three more electrons. Oxygen is formed when one more electron joins the group, which now begins to assume spherical symmetry. Two points of attack remain, however, and oxygen has a valence of two, and readily attracts to itself two atoms that have a single-valence electron, such as hydrogen. Thus one atom of oxygen and two of hydrogen form the water molecule, H_2O.

Although the structure that has been built up is static, it is also exceedingly dynamic; the positions of the orbits undoubtedly are in a continuous state of change.

When 10 charges and 10 electrons are present the group has remarkable spherical symmetry and the electrostatic field is fairly well neutralized, with the result that the element composed of such atoms affects its neighbors very little and has a valence of zero. It is an inert gas whose molecules consist of a single atom, do not even combine with other molecules of their own kind and form no chemical combinations. It has an extremely low boiling-point and has been reduced to temperatures around —200 deg. fahr. before it could be liquefied under pressure.

Atoms Ionized by Driving Off Electrons

The foregoing process of building up atoms to form other elements proceeds in periodic cycles up to radium, with 88 electrons with extremely complicated orbits. No attempt, however, was made to build up such a structure with the wire rings. Certain properties of atoms repeat themselves in what is known as the periodic table, and the atomic weight of elements increases in almost the same order as their nuclear charges. The whole behavior of the atom is a function of the electrons that lie on the outside of its structure.

Some of these outer electrons can be driven off in a variety of ways, as by applying sufficient heat to cause violent thermal agitation, as in the emission of electrons by thermal action of a hot filament in the vacuum tube. Or the atoms can be bombarded with high-speed projectiles, such as the electrons available from a heated filament and accelerated by a considerable potential difference so that they may be driven at high speed, or by particles emitted by a radioactive material like radium. This produces ionization by the removal of one or more electrons from the atom. Illumination by light of proper frequency also produces ionization by a simpler process. This is known as the photoelectric effect, and many substances are sensitive to ordinary light. Nitrate of silver in the photographic dry-plate is a familiar example.

Practical Application of Ionization Process

The photoelectric cell is now being applied to various practical purposes, according to Dr. Barker, who mentioned the setting up of such a cell on one side of a highway to count the automobiles that passed by changes in electrical

One-shot Lubrication

A bump in the road and a truck driver about to become a father were jointly responsible for the development of the Cne-Shot chassis lubrication system. The driver was preparing to deliver a 50-gallon drum of oil when word came to rush home. Speeding over a bump, he upset the drum, deluging the entire chassis, including its lubrication points, with oil.

Arriving home, he found it was a boy. Noticing that his oil-soaked truck worked splendidly, the new father occasionally upset an oil drum on purpose. Fired for carelessness, he took a correspondence school course in inventing, perfected the One-Shot Lubrication system and sold the rights for $23.98.

One of the Series of "True Stories of Auto Inventions" That Appeared in the *Daily SAE*

intensity caused by their shadows. The University of Michigan has, within a year or two, he said developed an instrument based on this principle that is used by the Timken Roller Bearing Co. for detecting defective finish on the surface of bearings. Light reflected from the surface upon the photoelectric cell causes the emission of electrons and produces an electric response. If the light is interrupted, as by a scratch barely visible to the eye, the electrical response stops instantaneously. The speed of this reaction is more rapid than 0.000001 sec. The bearings pass through this inspection instrument on a rotating spindle that drops them off at the end if perfect. If defective, the instrument automatically opens a trap and rejects them.

For further elucidation of the composition of elements by atoms of different structure Dr. Barker showed slides of charts of the atomic numbers of the 89 known elements, of the periodic behavior of the building-up process, of classifications of electrons, and of diagrams drawn in Copenhagen of the orbits of the electrons. The volume of the atom shrinks as the positive charge increases, but increases each time that the addition of electrons begins to form a new outer shell, hence we have gases and solids successively in the periodic table. The boiling-point depends upon the valence and the intensity of the electric field. The intensity with which two atoms will coalesce, and therefore the energy required to separate them, is a function of their electric charges and also of their diameters. Elements with the highest boiling-points, such as iron and platinum, are composed of atoms having the lowest volume, whereas those with the lowest boiling-points have the greatest volume.

China Undergoing Combination of Revolutions

China is faced today by the combined problems of Washington and Lincoln, declared Dr. Robertson in a thrillingly graphic presentation of the situation in the ancient but awakened Oriental country, accompanied by chalk maps drawn on the blackboard. It has Washington's problem of freeing itself from foreign domination that has lasted for 1000 years, and Lincoln's problem of unifying the peoples of the country itself. Added to these are the problems of throwing off an autocracy of 5000 years' standing, of educating 350,000,000 illiterates in a land of 400,000,000 population that is increasing at a rate of 1,000,000 per year, and of supplanting a manual industrial system with the Western mechanical system.

Some idea of the difficulties of the amalgamation, educational and industrial problems is conveyed by the speaker's statement that China is larger than Europe and contains 60 different nations, of which 30 speak the same language. It offers the greatest undeveloped commercial opportunities in the world today, and these wait upon the development of transportation facilities. All the railroad construction and equipment resources of the Western powers could be absorbed in the task of providing needed rail transportation, and 1,000,000 miles of highways are needed at once.

Great emotional activity stirs the huge population. An instance of this was the spread of a strike of electrical and public service employes in 5 days to a total of 150,000 following a mob attack in Shanghai in which five students were killed. This spread with amazing rapidity to great distances in the 5 days. Dr. Robertson also spoke of a war in China that lasted 15 years and resulted in the devastation of 600 cities and the killing of 20,000,000 people.

Struggle Against Autocracy and Domination

China is still in the midst of a conflict between democracy and an autocracy that has lasted 5000 years, according to the speaker, who asserted his belief that democracy will win, largely as a result of ideals acquired in America by Chinese students. It is also in the midst of a struggle to throw off foreign control that has lasted for 1000 years since the Mongols swept down from the north, followed 200 years later by the Manchus. In recent years many foreign countries have encroached upon the sovereignty of China until 40 such countries had foreign concessions in the land, were entitled by treaties to the privileges of extra-territoriality, and the Chinese awakened to the fact they were in bondage to these foreign governments, nine of which control the customs and force low import duties on imports into China of their own goods while imposing high import duties on tea and other Chinese products into their own countries. Extra-territoriality means that if a foreigner kills a man in China he cannot be tried in a Chinese court, but is tried in a court of citizens of his own country, and that the foreign concessions in all leading cities are governed by the foreign countries.

A great world movement that is going on is the emigration of Chinese to other countries. Dr. Robertson said he had seen 10,000 leave in a day for other lands. The impact of European and Oriental civilizations has produced volcanic upheavals of human elements. Sun Yat Sen, who got his republican ideas in England and, more especially, in the United States, set up a republican government in China, but a Northern viceroy sought by distributing his generals among the leading cities to dominate the situation and eventually to declare himself emperor. Sun Yat fled to Southern China and endeavored to reestablish a democratic civil government. He appealed for recognition and support to the United States and to the European powers, but they replied with the request that the question be made the subject of negotiations. All, except the Soviet government of Russia, which, foreseeing an opportunity of breaking down the capitalistic system in a land where it is not so firmly established as in Europe and America, promptly agreed and abrogated their unequal treaties.

Expects the Moderate Element to Win

The immediate situation, therefore, is the most important in centuries, as viewed by Dr. Robertson. America has come to be regarded no longer as a friend of China but as an oppressor. A determination exists to cancel the unilateral treaties with foreign countries and to abrogate the foreign concessions. The Southern Chinese, under Sun Yat Sen, started a military campaign against the conservative militarists of North China. The Southern Chinese are liberals and radicals, with a strong Russian influence. If they win in the conflict the country may become Bolshevik, but the leaders regard this as a price worth paying for national independence and unity. However, recently a split occurred between the moderate Southerners on the east to the south of Shanghai and the radicals on the west, but within a few weeks past these elements have arrived at a compromise and recombined their forces against the Northern militarists. The speaker intimated that he thinks the moderates will win eventually.

The mandarin culture in China was a successive growth by widening circles from a place northwest of Pekin. It absorbed successive small groups of communities. Upon the old Confucian philosophy of friendship Sun Yet Sen has grafted some new principles based on Western civilization. The Chinese remember friendly actions and are grateful and will reciprocate.

A Literary and Industrial Revolution

The country is undergoing a great literary as well as industrial revolution. As Europe threw off the handicap of illiteracy 600 years ago when the Latin language was discarded by such writers as Luther, Chaucer and Dante, so China is today endeavoring to teach its population to read and write. Industrial change is coming all over China, along with 15 or 20 other changes. Modern implements are beginning to be used to do work heretofore performed by hand. What this may mean to Occidental countries is indicated by the remark of a cotton goods manufacturer, who said that if 1 in. were added to the shirt-tails of all Chinamen it would keep all the cotton mills of England busy. Dr. Robertson did not, however, intimate what the eventual result may be if China starts the manufacture of her own cotton cloth and other goods.

A very interesting account was given of how the speaker introduced technical education to the officials in Foochow, a city of 300,000 population, by calling upon the mandarin

general who was the representative of the Pekin government and, as such, the most influential person in the city. Upon being granted an interview, he opened before the general a large case containing a microscope and other scientific instruments and spent an hour and a half explaining them, whereupon the general asked if it would not be well for other officials in the city to learn about them. The result was that 2 days later 150 or more officials were given a lesson in modern science, and subscriptions amounting to $48,000 were raised on the spot to build a school, although when he first went to the city Dr. Robertson was told the project was hopeless.

He also narrated how an epidemic of cholera that had caused thousands of deaths in Foochow was stopped by an American who organized a ½-mile procession of floats carrying significant messages to the population. One had a coffin at one end and a pile of firewood at the other, with a banner reading "Burn firewood and boil water or buy coffin." The next year there was no cholera.

There are now not less than 700,000 Chinese students learning to read and write through mass instruction in groups of 300 to 500 under one teacher, and the results are better than when the groups were only one-tenth as large. The movement is spreading so rapidly that all count of the students has been lost.

This awakening of China is most significant, Dr. Robertson asserted, and he concluded his address by leaving with his audience the thought expressed to him by one Chinaman, who inquired how long American civilization will last, and recalled China's 5000-year-old civilization as against the rise and fall of Assyrian, Egyptian, Greek, and Roman culture.

CHASSIS-DESIGN REFINEMENTS SUGGESTED

Resultant Probable Improvements Enumerated and Analyzed at Chassis Session

Consideration of tire-tread wear on front wheels as affected by camber, toe-in and the geometry of the steering-system, as well as an analysis of an internal-geared four-speed transmission, invited the attention of the members and guests who attended the Chassis Session that was held on Thursday morning, May 26. The paper on tire-tread wear was presented by J. E. Hale, manager of development for the Firestone Tire & Rubber Co., Akron, Ohio. It will be printed in full in a later issue of THE JOURNAL, but a brief abstract of its substance is printed herewith. S. O. White, chief engineer of the Warner Gear Co., Muncie, Ind., presented the paper on the four-speed transmission, which is printed in full elsewhere in this issue. It deals with means of obviating the car-noise that has become known as "high-speed rattle," which makes itself audible through the transmission case although it is caused mainly, according to the author, by periodic vibrations in the engine and of the propeller-shaft. The proceedings of the session were in charge of E. S. Marks, chief engineer of the H. H. Franklin Co., Syracuse, N. Y. Oral and written discussion followed the presentation of the papers, and a device for determining the proper amounts of toe-in and camber was explained and demonstrated.

TIRE-TREAD WEAR

Mr. Hale compared front-wheel and rear-wheel tire-tread wear and discussed their points of difference. He said in part that while the wear observed on rear tires is classified as "natural wear", the peculiarities observed occasionally on front tires are due to the mechanism of the car as embodied in camber, toe-in and the geometry of the steering system. He argued that camber and toe-in are likely to be found to be unnecessary and that steering-system geometry should be improved. In studying the peculiar wear on front-wheel tires, he stated that cases are found in which (*a*) the center or non-skid rib shows very little wear, and the shoulders on both sides show a great deal; (*b*) the center and one shoulder show little wear and the other shoulder shows a great deal; and (*c*) spots at irregular intervals around the tire are worn noticeably more than other parts, an effect called "cupping" or "spotty" wear. These conditions of abnormal front-tread wear are brought about by some scuffing action of a complex nature which is present as a result of restrictions from camber, toe-in or steering-system-geometry adjustments which interfere with pure rolling-contact. The proof that this is true is easily demonstrated by comparing the performance of tires made identical in every way and run under comparative conditions on front and on rear wheels. Mr. Hale then analyzed the three cases.

To secure normal tread-wear on front wheels, the speaker said that it is necessary to engineer the car so that there is rolling contact which is at all times strictly in the direction of the plane of the tire and with the absence of any lateral scuffing components. To accomplish this it would be desirable to have the front wheels straight up and down and with no toe-in when running forward, and with the geometry of the steering system worked out so that, in steering in either direction from that of straight ahead, the wheel direction would be such that there would be no toe-in or toe-out component.

Mr. Hale feels that it is desirable to stress the need of setting up the service stations so that they will be equipped to make adjustments not only on toe-in but to correct the camber of axles which have been put out of proper adjustment by bending or by wear of the parts, and also that these stations be able to restore the proper geometry of the steering-system. Once the correct camber, toe-in and steering-system geometry have been decided upon for any given car, it should be recorded in the instruction books so that it can be utilized through the use of the various toe-in and camber gages now on the market. The speaker emphasized the need for accurate adjustment facilities, particularly for toe-in. The features of the tie-rod design which provide for this adjustment should be modified wherever necessary so that a considerable degree of refinement can be attained.

Following the presentation of the paper, the device recommended by Mr. Hale for measuring toe-in and camber was shown and explained by A. E. Feragen, of A. E. Feragen, Inc., Detroit. It is not truly a wheel-aligning tool but a horizontal scale-board that weighs the amount of abrasion that exists because wheels are out of alignment. The base is made of metal. The movable board or horizontal platform upon which the wheel under test is run is fixed at one end on a king-pin and can move through an arc of 1½ in. at the end farthest from the king-pin, to the right and to the left. Ball-bearings are interposed between this movable board and the metal base of the device, the length being somewhat greater than one-half the circumference of the wheel under test. The device is laid on the floor and the car is pulled over it. If there is any abrasive action in either direction, either out from the center of the car or in from the center of the car, the sensitive movable board is thrust either in one direction or the other, away from the center of the car if the wheels are too wide and toward the center of the car if the wheels are not wide enough.

DISCUSSION ON FOUR-SPEED TRANSMISSIONS

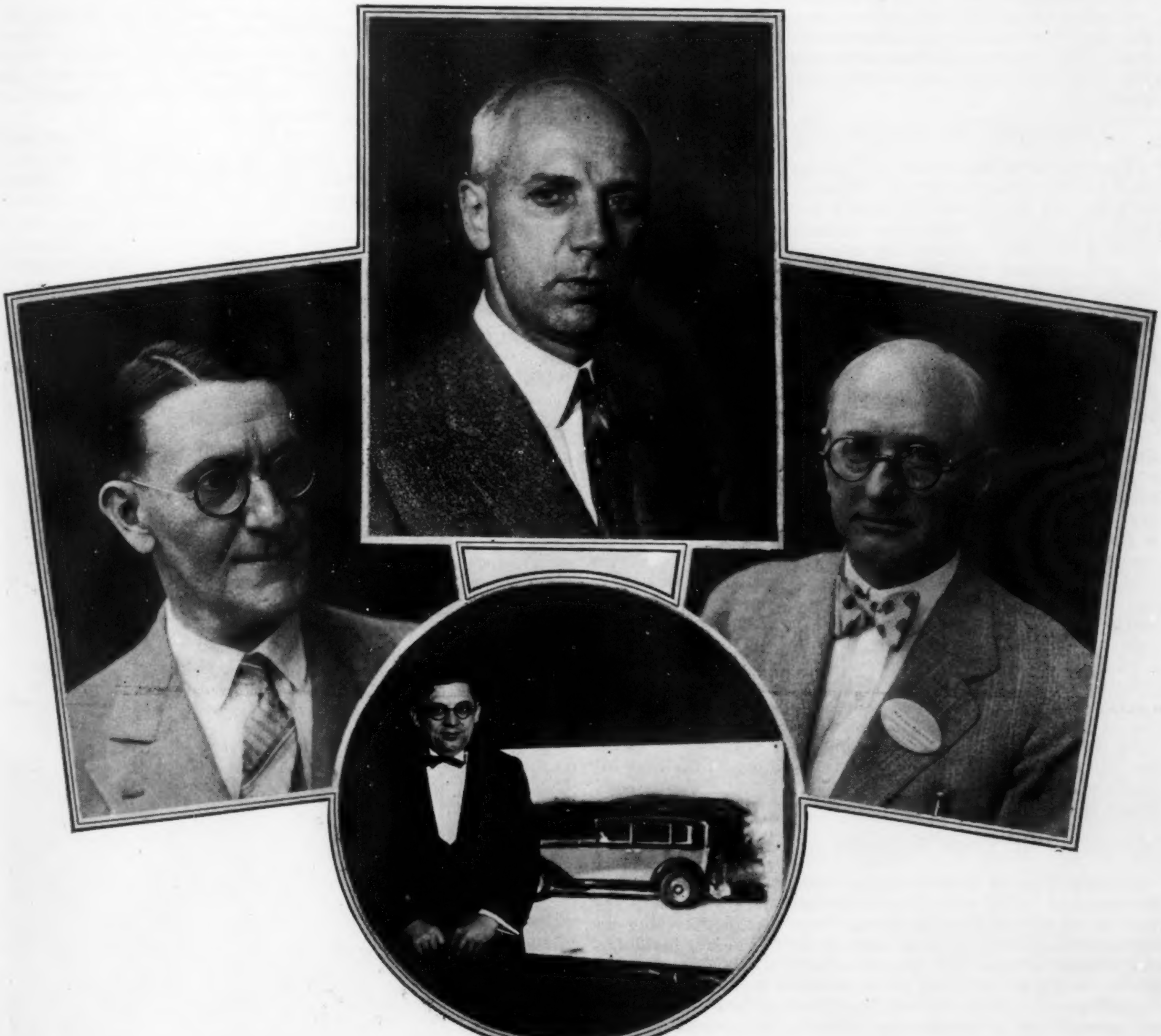
C. S. Crawford, chief engineer of the Stutz Motor Car Co. of America, Indianapolis, expressed his opinion that more money and effort should be expended toward the betterment of three-speed transmissions, because it is desirable to retain the simplest possible design for transmissions and also because the public must be educated to it if the amount of gear-shifting is to be increased. As to engine size and output, in his opinion it is possible to obtain materially better engine performance than is prevalent now and at the same time to make the engine smaller and of less weight. He advocates working toward greater simplicity, better fuel-consumption and increased horsepower-output per pound of engine weight.

Robert Lapsley, chief engineer of the Detroit Gear & Machine Co., Detroit, submitted an analysis of the desired type of four-speed transmission. He said in part that since the tendency in car design undoubtedly is toward lighter

cars, the designer must not add very much weight. As the engine supports already are very heavily loaded, added weight must be concentrated as closely as possible to these supports. Bearing in mind these two essentials, the desired transmission, although slightly heavier than the present type, should not overhang to any considerable extent more than does a standard three-speed transmission. This would produce a transmission somewhat more chunky but of no greater length than that of a standard spur-gear four-speed transmission. The design should be such that, at top speed or direct, no gears would turn. In the second high, the term for designating the speed on the internal gear, only the internal-gear-drive parts should rotate all other gears in the transmission being disengaged and not rotating. As it would not be economical to make the other speeds in the transmission of such an expensive design as that of the internal drive, there would be, of necessity, a second speed, a low speed and a reverse as nearly like the standard three-speed-transmission idea as possible.

W. G. Wall, consulting engineer, Indianapolis, said that the four-speed transmission is not an acceptable proposition unless the third speed can be made quiet. F. E. Moskovics, president and general manager of the Stutz Motor Car Co. of America, remarked that the trend in Europe is toward three-speed gearboxes on the better cars. In his opinion, the degree of high-speed ability that it is desirable to attain is the first part of the problem, and he said that this can be determined easily by making acceleration tests on high gear in increments of 5 m.p.h. up to say a car-speed of 50 m.p.h. With the attainment of that high-speed ability, which means hill-climbing ability, it is then necessary to determine what performance the range of engine characteristics will permit.

In opposition to the plea for larger engines and greater power made by Mr. McKim, representing the Hercules Motors Corporation, Canton, Ohio, Thomas L. Fawick, Racine, Wis., stated his opinion that the use of larger engines would constitute an unjustifiable waste and said that a car will make mileage over the thousands upon thousands of good smooth roads in this Country when a small engine is used, if equipped with proper gear-ratios. When furnished with a proper transmission and with suitable driving-ranges a car can negotiate most hills on fourth gear when it is up to car-



AUTHORS AT BODY AND CHASSIS SESSIONS

J. E. Hale (Upper Center) Discussed Pitch, Toe-In and Caster and S. O. White (Left) Discussed Four-Speed Transmissions at the Chassis Session. A. E. Northup (Lower Center) Discussed Body Designing at the Body Session, Presided Over by W. R. Strickland (Right)

speeds of 35 to 50 m.p.h. On smooth level roads, very little power is required and the effect of driving on fourth gear is very like that of coasting.

F. C. Thompson presented details of an internal-gear unit for transmissions[1] that has been developed by the Morse Chain Co., Ithaca, N. Y.

FUNDAMENTALS OF BODY DESIGN

Build Body Around Passengers for Comfort—Use Cheat Lines for Beauty

Friday night's Body Session might be likened to a three-ring circus. It was made short and snappy by the simultaneous reading by L. Clayton Hill of a paper on body design by A. E. Northup, design expert of the Murray Body Corporation; the drawing in pastel colors of a handsome sedan on the blackboard by Mr. Northup, and the projection of lantern slides of other body designs and of drawings on the screen. W. R. Strickland of the Cadillac Motor Car Co., who presided as chairman, omitted any introductory remarks and after the address adjourned the session without calling for discussion so that the ballroom might be cleared for dancing. The audience watched with absorption the growth of Mr. Northup's color design while listening intently to the paper.

Appearance and Comfort the Major Factors

Creation of a body that will possess maximum sales appeal is the objective of the automobile body designer and builder, and attractive appearance and comfort are the two major factors that determine salability. The development of pleasing body outlines and contours is not a mechanical or mathematical problem, according to the author of the paper, who deprecated the tendency of car-company executives to project their ideas into the work of the designer instead of leaving the creation of designs wholly in his artistic hands.

Passenger comfort demands, he said, that the body be built around the passengers, and certain fundamental minimum dimensions should be adhered to religiously. Among these are head-room, or distance from seat cushion to head-lining; leg-room, from seat-back to pedals or toe-board; seat width, particularly at the shoulder height; and door widths. Bodies on short chassis must be made high, since the passengers must sit upright, and the apparent height of the body is exaggerated by this shortness. Hence the designer must resort to the use of optical illusion to create the impression that the body is longer and lower than it really is. This is accomplished by the employment of cheat lines, which are also useful in reducing or increasing the apparent width of the body as viewed from the front and rear.

Slides were thrown on the screen to illustrate cheat-line practice in the case of window design. The first slide showed a series of three equal-size rectangles representing the practice of years ago in side windows of sedan bodies. By contrast the second slide showed two longer windows of equal size and a third window much shorter. Although the over-all length of both groups was the same, the second group seemed longer than the group of three square windows.

Horizontal Lines Increase Apparent Length

A third slide, of a body design incorporating the window arrangement in the second slide, further illustrated the principle of employing long horizontal lines and obliterating as much as possible the vertical lines in short bodies. Moldings and reveals around the windows were treated in a color scheme in a way to tie all three windows together in a long shallow group. Along the sill line was a rather broad molding painted in a contrasting color to accentuate length. Vertical lines around the doors were not marked by moldings or color but were of the flush type and barely noticeable.

The insertion of raised panels running back over the bonnet and blending into the cowl was another example of cheat-line practice. These panels are painted in a contrasting color, to lead the eye fore and aft. The so-called horse-shoe molding is sometimes incorporated in the back panel of the body below the belt to break up the wide expanse and, as its lines are mostly vertical, the effect is to diminish the apparent width without emphasizing the height. This illusion is further increased by use of a rear window that is more nearly square than the side windows.

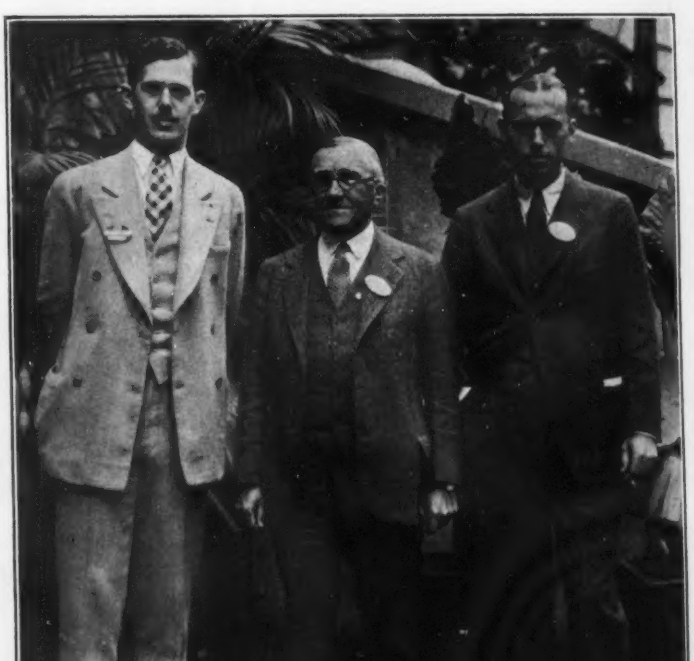
Fenders and Other Parts Should Harmonize

Length and grace of body form are enhanced by attractive fender design, an appearance of lightness and forward motion being given to the complete car by employment of long sweeping front fenders. Similarly, the radiator, hood, splashers, running-boards, head-lamps and even lamp tie-rods, radiator filler-cap and the like affect the harmonious appearance of the design, and for this reason it seems best, according to Mr. Northup, that the entire outer shell of the car be designed by a single individual whose training and talents are artistic rather than mechanical.

The wide shallow form of door window that is best for appearance is fortunately also best for comfort, as it assures adequate vision, and the greater width of door affords ample entrance and exit openings. Given a wide front door, the body builder can use the same door and pillar stampings for sedans, coupes and cabriolets.

Color treatment should be kept constantly in mind when laying out the body design, as by proper utilization of contrasting colors certain features of a body can be accentuated to make the complete car most striking in appearance.

Style in body lines should logically change from year to year, asserted Mr. Northup, and the designer must be ready with new ideas and must seek novelty to intrigue the motoring public.



Some of the Representatives of the Press
Reading from Left to Right, A. F. Denham, Fred H. Colvin and Norman Shidle

[1] See *Automotive Industries*, May 21, 1927, p. 766.

FOR AND AGAINST DOUBLE FOCUSING

Both Sides of Question, Non-Focusing Suggestion and Wet-Road Effects Presented

Whether a vertical-focusing adjustment, in addition to a horizontal-focusing adjustment, in two-filament head-lamps is or is not desirable held a group of headlighting investigators in rather intense debate until 12.45 a. m. at the Headlighting Session on Thursday night. The subject is not alone one of scientific and engineering interest, but has significance for car and lamp manufacturers and for owners of motor-vehicles because of the opposed views of some of the State motor-vehicle administrators. Headlighting requirements and restrictions, and especially the lack of uniformity of them in the various States of the Union, are held by headlighting experts to be responsible for impeding progress in the solution of this vital problem, and a single uniform set of lighting regulations in all the States framed so as to allow development along any line that will result in less glaring head-lamps but more satisfactory driving illumination is ardently desired.

Opposed sides on the question of double-focusing head-lamps were taken by W. W. Matthews, of the Bureau of Motor-Vehicles of Pennsylvania, who advocated the use of the vertical-focusing adjustment, and A. W. Devine, of the Registry of Motor-Vehicles of Massachusetts, who held that this adjustment is an unnecessary and confusing complication.

How Wet Roads Affect Illumination

The session, over which Dr. H. C. Dickinson, of the Bureau of Standards, presided, was opened with a paper prepared jointly by R. E. Carlson and W. S. Hadaway, of the Edison Lamp Works of the General Electric Co., and presented by Mr. Carlson, on the effect of wet roads on head-lamp illumination, a subject of no little interest, but one that has received little attention. This was liberally illustrated with lantern slides of photographs showing the distribution of light with symmetrical and non-symmetrical systems, with high and depressed beams, and with both dry and wet floors or road surfaces in the laboratory and on the street.

The tests that were described were made at the lamp works in Harrison, N. J., with head-lamp test equipment consisting of two pairs of especially constructed head-lamps mounted on a standard for use in the laboratory and mounted on a bar across the front of the car for road tests, with suitable control apparatus for lighting any single lamp or pair of lamps and for switching on either the upper or lower filament of the two-filament lamps. For the road tests this apparatus was mounted on one car, from which photographs were taken, and the S. A. E. test equipment, similar in nature, was mounted on an approaching car. Light-screens marked off in 1-ft. squares and set at distances of 57 and 85 ft. from the head-lamps showed the distribution of light in the laboratory tests, and photographs taken from the observation car looking toward the approaching test-car showed the effect of the various beams from both cars.

Non-Symmetrical System Gives Best Results

The tests and photographs showed that a wet road surface changes the distribution of the light materially and when the depressed beam is used reflects the light upward above the line of vision and increases the apparent candle-power, so that more glare is produced. When meeting a given light-distribution, higher intensities are required to reveal an object on a wet asphalt road than on a dry one, due to greater interference with vision and also to the change in distribution. Increasing the light intensity in a symmetrical system, in which the beams are directed straight ahead, does not, however, give greater revealing power on a wet road.

It was made evident that better driving vision is had and less glare produced in the eyes of approaching drivers when a non-symmetrical system is used in which the high-intensity portion of the beam is directed to the right of the axis of the car. Advantages for driving on both dry and wet roads are possessed by a beam of very wide spread and low intensity near the car in conjunction with a relatively narrow controllable high-intensity driving beam.

Other conclusions reached are that auxiliary driving lights in which the beam is directed to the right of the car axis afford a better view of the right side of the road, tend to keep the driver's eyes directed away from the lights of an approaching car, and their use should be encouraged; and, finally, that rigid adherence to the use of two 21-cp. lamps has resulted in insufficient light flux to meet all requirements.

In the non-symmetrical system tested, a two-filament lamp was turned in the head-lamp shell so that the two filaments were in a horizontal plane and the beam from one was directed straight ahead whereas when current was shifted to the other filament the beam was directed to the right of the axis of the car.

Before proceeding to the next paper, Chairman Dickinson asked R. N. Falge, vice-chairman of the Lighting Division of the Standards Committee, to describe the demonstration test-apparatus that had been set up in front of the rostrum for use at the session. This, Mr. Falge explained, consisted of a standard carrying a pair of tilting-ray head-lamps and a pair of twin-beam head-lamps. The first pair were of single-focusing type and the other pair of the double-focusing type. No changes had been made in one pair but the other pair, which were identical in performance so far as distribution of light on the screen was concerned, were provided with a mechanism at the rear of the reflector for moving the incandescent lamp in its socket through known amounts to simulate effects produced by inaccuracies in filament placement and other lamp inaccuracies. Current from a pair of batteries, and a set of switches, made it possible to light any lamp or filament as desired.

Another piece of apparatus was a stereopticon for projecting enlarged shadow pictures of filaments in lamps on the screen, which was set in the corner of the room. Two sets of lamps regarded as defective had been submitted by members of the Society, said Mr. Falge, so that they might be placed in the head-lamps to show results that would be obtained by using such lamps in the head-iamps on cars.

In Advocacy of Double Focusing

In a prepared address, Mr. Matthews, announced as the second speaker, explained why the State of Pennsylvania maintains that the vertical-focusing adjustment is necessary with two-filament lamps. With a tolerance of 3/64 or 1/16 in. in axial alignment of the filaments in lamps, it is necessary, he held, that means be provided in the head-lamp for compensating for this error and that a summary of tests of single-adjustment tilting-ray head-lamps, made by the Pennsylvania Bureau of Motor-Vehicles in June, 1926, shows vagaries of lighting that the proponents of single adjustment have not been able to explain. After two types of single-adjustment depressible-beam head-lamp had been approved by the Bureau of Motor-Vehicles, the next two-filament device submitted incorporated two adjustments, and it was evident that the engineers who developed the device were convinced of the necessity of the vertical adjustment. In a casual summary it is possible, said Mr. Matthews, to name at the present time at least 16 automobiles of standard and widely used makes that have adopted double-adjustment head-lamps, as against 6 makes equipped with single-adjustment head-lamps.

He maintained that it is not impossible to issue clear and direct instructions for the adjustment of double-focusing head-lamps. Beginning Jan. 1, 1928, the Pennsylvania Bureau of Motor-Vehicles will designate approved adjusting stations, and he is sure, he said, that the inspectors will not jeopardize their positions by inability to promulgate and disseminate the necessary instructions. The Bureau is now giving an instruction course to the municipal police of Pittsburgh, where six traffic officers have been designated as a headlight squad and with six other officers from sur-

rounding municipalities are being given instruction in head-lamp adjustment by one of the Bureau's inspectors, who reported that he was impressed with the manner in which these men were able to adjust the two approved types of multiple-adjustment head-lamp after a short explanation.

Uses Vertical Adjustment for Aiming

Why, inquired the speaker, should not the vertical adjustment be used for aiming the beam? So far as enforcement of the regulations is concerned, it is the aiming of the head-lamps that determines whether or not the beam is projected into the eyes of approaching persons. The easier it is for the car owner to regulate the angle of the beam, the more likely is the beam to be inoffensive. His theory of what seems to be an ideal head-lamp is one that complies with the laws, specifications and regulations, but when a lamp is inserted, if the beam is too high, the lamp is turned down, and if the beam is too low it is turned up. This operation would certainly be within the range of the average driver's intelligence, he declared. If the efforts of head-lamp manufacturers were concentrated upon the construction and marketing of the best possible type of complete head-lamp, the aim which all are seeking, he asserted, would be accomplished. The adjustment of carbureters and four-wheel brakes is more intricate than the taking of a couple of turns on a screw with a screwdriver.

Within the preceding 2 weeks three Pennsylvania highway-patrol headlight details stopped 921 passenger-cars representing 47 makes, and of this total 536 operators, or 57 per cent, knew the use of the adjustment screws. But only 145, or slightly more than 1 per cent, had ever personally used the nut under the S.A.E. Standard mounting to tilt their head-lamps. He would attempt to show, continued Mr. Matthews, that use of the vertical adjustment for aiming does not disregard the best adjustment of the lamp and result in distortion of the beam. The vertical adjustment provides a quick method of properly aiming the beam and a correction for imperfect alignment of the filaments in the lamp. If a bulb properly or improperly manufactured is placed in the head-lamp and focused by the usual method, and the vertical adjustment is used to position the lower filament relatively to the axis of the reflector so that the tops of both beams are at the same height, the double object of compensating for filament inaccuracies and of aiming the head-lamp has been accomplished.

Half of Pennsylvania Head-Lamps Adjusted

Turning to head-lamp adjustment in practice, the speaker cited reports from the headlight squad of the Bureau of Motor-Vehicles showing that slightly more than 50 per cent of the head-lamps in the State are in proper adjustment, and ventured to say that an analysis of the other cases would show that a majority were not improperly focused but that the beams were aimed too high.

Real improvement can be obtained, the speaker agreed, only when head-lamps are constructed so that the necessity for scientific knowledge on the part of the car operator is eliminated, but he does not see, he said, that the situation with regard to the double-filament lamp is made any clearer by eliminating the vertical adjustment, as the driver still will have the burden of focusing and aiming. He believed, he said, that the action of the Eastern Conference of Motor-Vehicle Administrators has stimulated development and has resulted in movements to experiment with new methods of projecting light, and that insistence on two adjustments has pointed the way to the construction of satisfactory devices with the minimum of adjustments.

Data assembled by Pennsylvania in collaboration with New Jersey, continued Mr. Matthews, led to the conclusion that head-lamps and two-filament incandescent lamps, as now manufactured and sold, are of such a character that the results desired and claimed cannot be obtained unless some provision is made for accurate adjustment. In conclusion, he asserted that insensitive head-lamps cannot become a reality until head-lamp manufacturers give more consideration to the motorist and less to the purchasing agent of the motor-car company, that the vertical adjustment can be used for aiming the beam without serious results and that it may displace the S.A.E. Standard mounting for this purpose. Finally, he made the prophesy that, if ever an ideal lamp is designed with no adjustments, and in the interim it is necessary to get along with only one adjustment, that will be a vertical adjustment.

Vertical-Focusing Adjustment Superfluous

The opposite side of the whole question was taken by the third speaker, A. W. Devine, of the Registry of Motor-Vehicles of Massachusetts, whose paper is printed in another section of this issue of The Journal. Supplementing his prepared paper, as printed, he said that the single and double-focusing types have been in service long enough to ascertain whether the additional vertical focusing mechanism has improved conditions or otherwise. A tabulation of results of a survey made by six inspectors attached to the Registry of Motor-Vehicles on 625 cars equipped with double-filament tilting-beam head-lamps of both the single and double-focusing types in Boston, Lynn and New Bedford showed that only 11.6 per cent of 456 single-focusing head-lamps were not properly adjusted and that 37.3 per cent of 169 double-focusing head-lamps were not rightly focused.

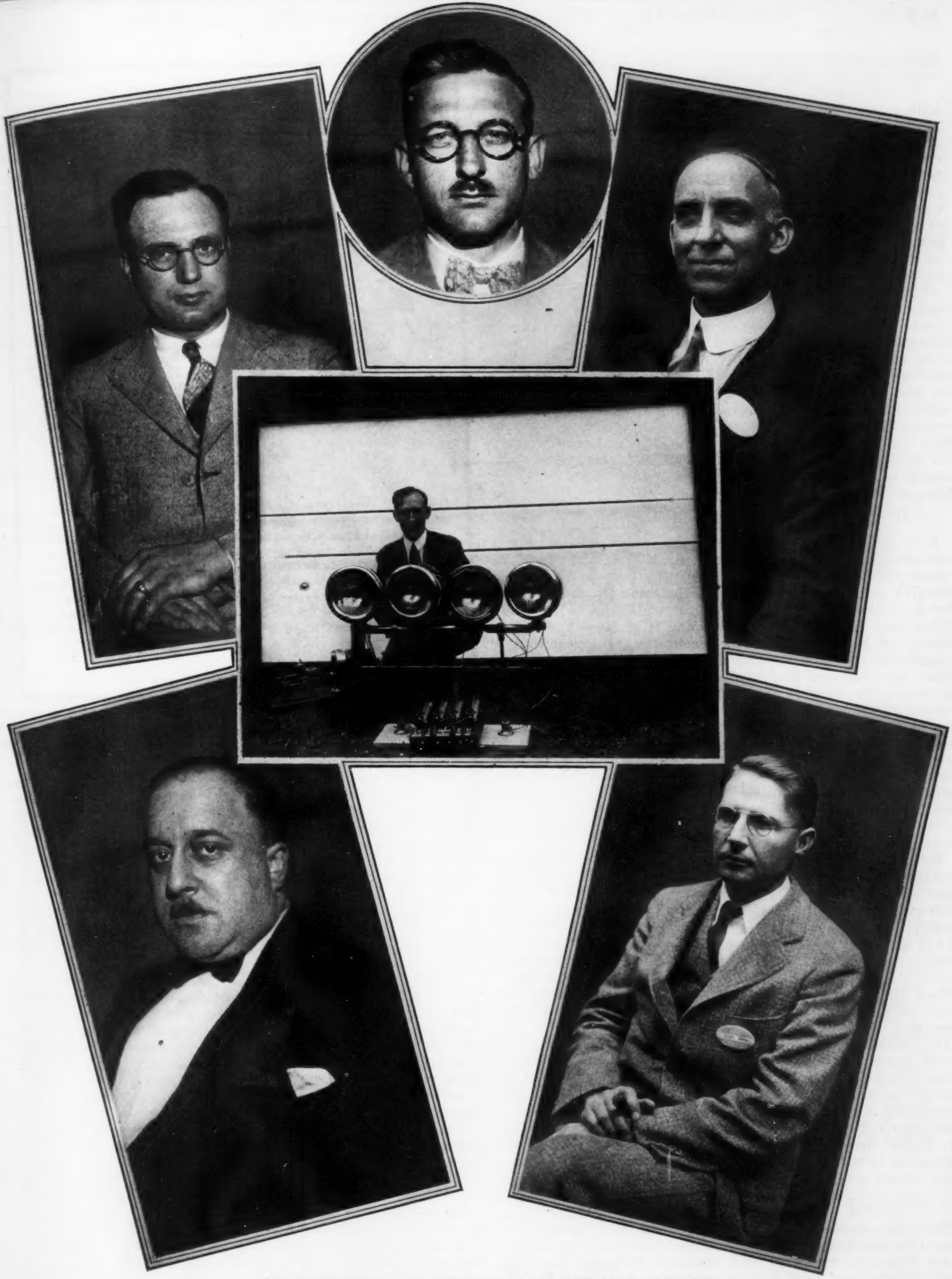
Furthermore, of the 625 cars, 443 had head-lamps which were classed as focused, judging by the appearance of the upper beam only, and were so tabulated by the inspectors that they could be classified separately under (*a*) those with definite cut-off and downward tilt, (*b*) those with no tilt or negative tilt and (*c*) others with an indefinite cut-off for the upper beam. Of these 443 cars, 308 had single-focusing head-lamps and 135 had double-focusing head-lamps. In this second summary 99 per cent of the focused single-adjustment head-lamps were entirely satisfactory in performance and only 1 per cent had an indefinite cut-off for the upper beam. On the other hand, only about 64 per cent of the focused double-adjustment head-lamps were entirely satisfactory, while about 36 per cent had no tilt or a negative tilt or an indefinite cut-off of the upper beam.

The same tabulation showed a variation in tilt between the upper and lower beams ranging from 8 to 20 in., or a difference of 12 in., for the single-adjustment type, whereas the double-adjustment type showed a range of variation from a downward tilt of 20 in. to an upward, or negative, tilt of 5 in., a total range of variation of 25 in., or more than double the variation of the single-adjustment head-lamps.

A Simple Practical Remedy Proposed

Written discussion on the focusing problem was submitted by C. C. Bohner, of the Tung-Sol Lamp Works. A number of fixed-focus head-lamps are in use in which the light source is nearer the focal area of the reflectors than in 80 per cent of the accepted adjustable types on the road today, regardless of whether they are of the single, double or universal type of adjustment, he said. The time is right to begin the use of a fixed-focus receptacle. Four years ago it would not have been reasonable to depend upon a high percentage of the incandescent lamps on the market to come within fixed-focus limits, but the increased ability to manufacture to greater accuracy has brought a change in the situation.

One of the most discouraging features in the control of the light-source position has been the base, which acts as a terminal and as a locating device for the lamp in the socket. This base varies 0.008 in. in diameter, 2/64 in. from the open end of the shell to the locating pin, is larger at the contact end than at the open end and is rarely truly cylindrical. Because of these inaccuracies it is difficult to place the base on the glass bulb so that the center lines of both are parallel, or co-axial, as no satisfactory means of doing so exists. In almost every case of rejects thrown out because the light source was out of position more than 3/64 in., the filament had been positioned with regard to the bulb center line, but was thrown off in the process of basing. Added to these



CELEBRITIES AT THE HEADLIGHTING SESSION

Dr. H. C. Dickinson, Chairman (Upper Right); A. W. Devine, Who Sponsored Single-Adjustment Head-Lamps (Upper Center); W. W. Matthews, Who Sponsored Double-Adjustment Head-Lamps (Lower Left); C. C. Bohner, Who Sponsored Fixed-Focus Head-Lamps (Upper Left); R. E. Carlson, Who Discussed the Effect of Wet Roads on Illumination (Lower Right). R. N. Falge and Headlighting Equipment Used in Demonstration Appear in Center

inaccuracies are the possibilities for deviation in the sleeves, sockets and focusing mechanism.

In the process of locating the filament in the bulb, the bulb is held in a fixture so that the light source is always located with definite relation to fixed reference areas or rings. Mr. Bohner therefore suggested the use of a fixed ring secured to the reflector without adjustment means, this ring to be of the same size and shape as the reference ring used in the manufacturing process. This will eliminate all of the inaccuracies that occur in base manufacture as well as most of those that occur in the lamp-fabrication process. This ring would be moved slightly toward the maximum diameter of the bulb and, instead of being 0.600 in., would be approximately 0.6875 in.

The method suggested would, according to Mr. Bohner, make it possible for the car owner to release a burned-out lamp from the fixed ring merely by pressing forward a plunger, and when installing a new lamp his only consideration would be to release the plunger, which would automatically seat the lamp in the ring. Vibration only tends to seat the lamp more firmly in its correct location. No difficulty would be experienced in servicing the first cars equipped with these adapters, as any lamp that is satisfactory for installation in this ring would also be satisfactory for installation in the present conventional socket. And there should be no added cost in the manufacture of the bulb, the lamp or the reflector assembly.

Demonstrations Prolonged Past Midnight

Most of the rest of the discussion period was occupied with demonstrations of head-lamp adjusting to show the difficulties encountered by a car owner who is inexperienced in focusing and aiming head-lamps. Chairman Dickinson called for a volunteer to make the adjustments and, when none other came forward, Charles M. Manly, of New York City, offered his services. As he is a consulting engineer and is experienced in both writing and following instructions in other lines, he had fair success, although he had difficulty in judging the relative intensity of the light at different adjustments with the double-focusing head-lamp when following the printed directions issued by a manufacturer. Various inaccurate lamps were afterward inserted in the head-lamps to show the light distribution with them first one side up and then reversed, and with the upper beam and the lower beam switched on. They were tried repeatedly in both the single-focusing and the double-focusing head-lamps and it was very difficult to see that any better results were obtained with them in the latter type than in the former one.

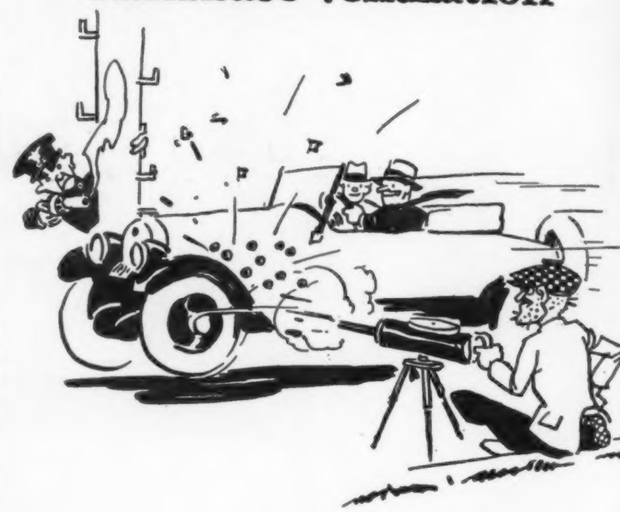
W. D'Arcy Ryan, of the General Electric Co., remarked that the papers delivered and the demonstrations convinced him more than ever that adjustment must be done away with entirely. Car builders, in their instruction books, omit instructions on head-lamp adjustment, he thought, because of the diversity of opinion and the variation in State headlighting requirements, and are waiting until the controversy on the subject is settled. He made a plea for uniform regulations all over the Country and for the acceptance by all States of one tribunal of resort on the question of specifications and tests.

Dr. Dickinson explained that several members of the staff of the Bureau of Standards, after spending a day in head-lamp-adjusting tests, reached the definite conclusion that the best adjustment that could be obtained with the double-adjustment units was not in a single case appreciably better than they could get with the single-adjustment head-lamp. Mr. Falge stated that it seems very necessary that some agreement be reached, as motorists are being penalized, accidents caused and progress delayed by the present situation.

Head-Lamps Compensated for Inaccuracies

Speaking as chairman of the Lighting Division of the Standards Committee, C. A. Michel, of the Guide Motor Lamp Mfg. Co., said that it is realized generally that the S. A. E. Standard head-lamp mounting is not ideal, but it was approved to correct a condition that existed about six years ago; the Lighting Division is now about to consider its shortcomings and try to eliminate them. He invited anyone who had views on the subject to submit them in writing to the Society.

Crankcase Ventilation



Gregory J. Spavin, of Chicago, noticed recently that his car was suddenly free from crankcase dilution, engine halitosis, and sludge in the oil pump—three of its permanent ailments. Curious, he raised the hood to investigate. He noticed a gaping hole in the crankcase through which the fan draught was industriously sucking the torrid vapors. Racking his memory to account for the hole, he recalled an encounter between bandits and police which had amused him greatly. With a Chicagoan's insouciance, he had driven through the machine-gun fire which a thug was directing at a bluecoat. The car had stopped one of the bullets, apparently—giving the world Crankcase Ventilation.

Another of the Series of "True Stories of Auto Inventions" That Appeared in the *Daily SAE*

With reference to the two-filament lamp, he said that the matter of tilt was one of the most important things, and by establishing a depression of the top of the upper beam through an angle of 2 to 3 deg. to the top of the lower beam, the devices were thrown into two classifications: (*a*) sensitive, or uncompensated; and (*b*) insensitive, or compensated. In the former the amount of tilt is very sensitive to placement of the lower filament and, if the requirements of the Eastern Conference of Motor-Vehicle Administrators are adhered to, it is necessary to have a second adjustment if the filament is to be placed within the range of the tilt.

In designing a compensated device, on the contrary, commercial variations in filament placement are recognized and those parts of the device that react unfavorably to these variations are desensitized and the light is tilted downward sufficiently to disregard the variations throughout the range that the tilt is retained. Therefore the device falls in the class of the single-filament lamp inasmuch as its filament is on the axis. It operates better than the commercial single-filament device because it is less sensitive and because the two-filament lamps are made more accurately today than the single-filament lamps.

HEADLIGHT DEMONSTRATION HELD

An extended indoor session on Thursday night and torrents of rain on Friday night prevented the formal outdoor headlighting demonstrations scheduled for those two dates. However, nothing could quench the spirits of the enthusiastic students of the headlight problem who have been cooperating in the investigation being carried out by the Illuminating Engineering Society and this Society, nor diminish the interest of the engineers less directly connected with

the work of the joint research in the test equipment developed in its course.

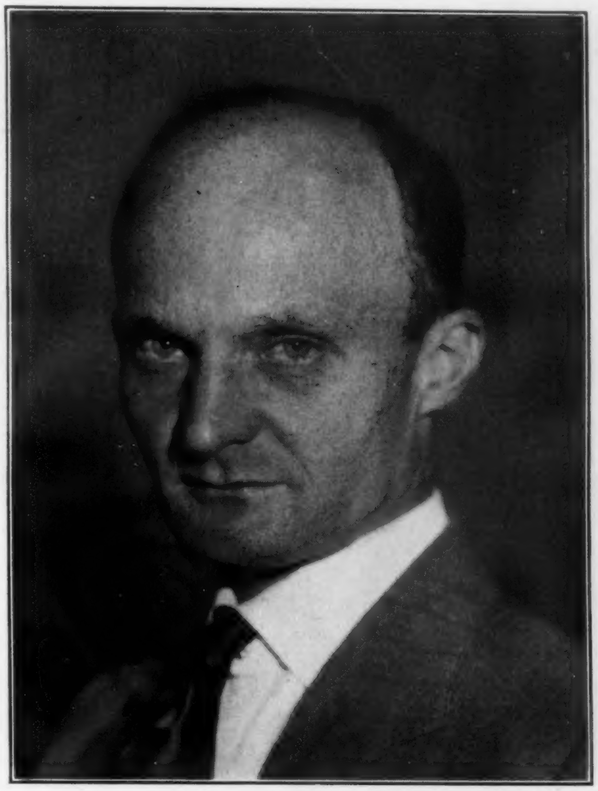
Several cars fitted with the test equipment were available and were driven about to illustrate some of the tentative results arrived at by those whose interest has been actively enrolled in the research. The roads about French Lick Springs offer an ideal field for such a demonstration, including in their scope almost every variety of grade, curve and surface construction. Among those who were on hand to show lighting distributions that they thought suitable to furnish illumination where it is most needed on the highways were Dr. H. C. Dickinson, of the Bureau of Standards; R. N. Falge, of the General Motors Corporation; W. M. Johnson, of the National Lamp Works of the General Electric Co., and C. A. Michel, of the Guide Motor Lamp Mfg. Co.

An indoor demonstration of unusual interest followed the Headlighting Session on Thursday evening. A four-headlamp equipment, similar to that developed for the joint research of the Illuminating Engineering Society and this Society was set up opposite a screen on which the light distributions were thrown. Methods of adjustment for single-adjustment, double-adjustment and fixed-focus head-lamps were shown. Much of the credit for this demonstration belongs to Messrs. Falge and Johnson, who spent time, effort and care in arranging the set-up.

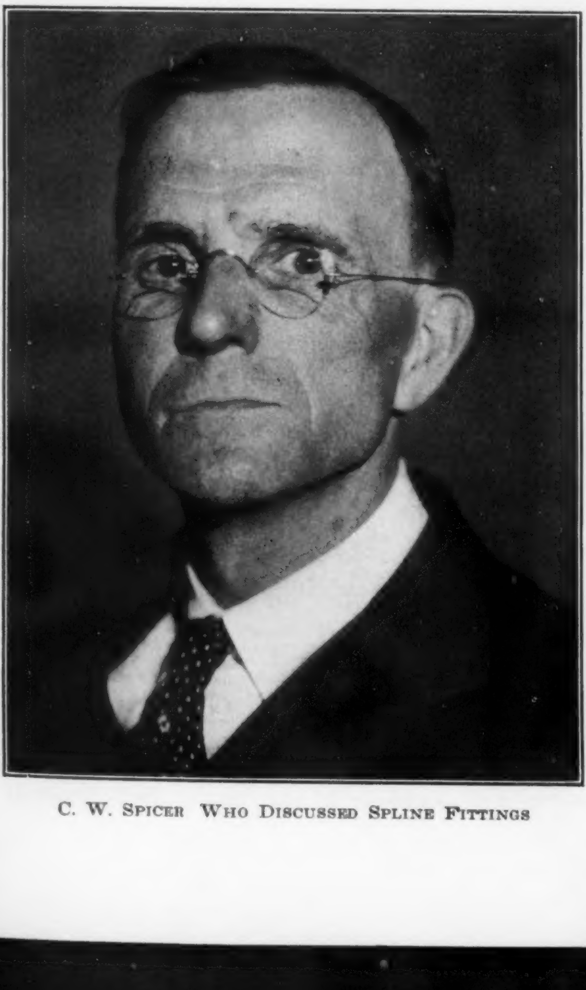
RESEARCH SPEAKERS VERSATILE

Fuels, Lubricants, Philosophy and Humor Feature Lengthy Research Session

Wherever two or more engineers are gathered together, that is a research session, and many of these impromptu, intimate reviews of automotive developments and investigations took place during the Summer Meeting; and research had, too, its formal day, or rather half day, of information and inspiration Friday morning. Under the genial chairmanship of R. E. Wilson, of the Standard Oil Co. of Indiana, five papers were presented, in which were represented philosophy, the details of test methods and of definite investigations, and humor. The speakers and their papers were: W. S. James, Studebaker Corporation of America, Relation of Research to Industry; Lean Explosive Limits for Hydrocarbon Fuels, written by D. C. Ritchie and presented by H. K. Cummings, both of the Bureau of Standards; J. O. Eisinger, Bureau of Standards, Engine-Acceleration Tests; Dr. M. R. Schmidt, Standard Oil Co. of Indiana, Specification-Writing for Petroleum Lubricants; and C. W. Spicer, Spicer Mfg. Corporation, Torsional Strength of Multiple-Splined Shafts. Among those who contributed to the interest of the session by their comments on the subjects covered by the papers were David Beecroft, vice-president, Chilton-Class Journal Co.; H. L. Horning, Waukesha Motor Co.; R. V. Hutchinson, Olds Motor Works; B. J. Lemon, United States Rubber Co.; and W. G. Clark, Pure Oil Co.



W. S. James Who Discussed Relation of Research to Industry



C. W. Spicer Who Discussed Spline Fittings

Mr. James, who has followed his vocation and his avocation of research on both sides of the Country and is now attaining good geographical distribution by pursuing it in the Middle West, gave a keen analysis of the qualifications of a research man and of the place of research in industry. His paper was not a report of a fact-finding investigation, but an arresting psychological research into research.

With the object of stripping research of its traditional, but mythical, mysterious and uncanny atmosphere and permitting its real fundamentals to stand out, Mr. James drew a comparison between the modus operandi of such noted investigators as Henry Cavendish, Lord Rayleigh and Sir William Ramsay and that of Abie O'Brien trying to solve his difficulties with his four-cylinder, planetary transmission car. All of them, he said,

> were either curious or confronted with a definite problem. Their curiosity was more or less satisfied by actual trial, not aimless discussion. Their problems were solved by guessing with greater or less accuracy at the probable answer and checking the guess or hypothesis by experiment.

As a step in encouraging investigations aimed to forestall and solve in advance the problems that may confront the automotive industry in future, Mr. James recom-

J. O. EISINGER WHO DISCUSSED ENGINE-ACCELERATION TESTS

mended that a scheme of closer cooperation between industry and universities be worked out.

COOPERATIVE FUEL RESEARCH FURNISHES TWO PAPERS

Two of the papers reported results of the Cooperative Fuel Research, which has been carried out for several years under the sponsorship of the National Automobile Chamber of Commerce, the American Petroleum Institute and this Society at the Bureau of Standards. They represented substantial contributions to the fund of knowledge on the factors affecting the operation of fuels in engines which is being built up by the joint investigation on the firm foundation of carefully planned and accurately controlled tests.

The tests, reported by Mr. Ritchie and presented to the Research Session by Mr. Cummings, were carried out to answer the question as to the relative starting characteristics of cracked and straight-run gasoline. To deal with this problem, a method of determining the limiting explosive mixtures of air and fuel vapor was developed and applied to numerous motor fuels. The data obtained indicated that a lean explosive limit of a 25 air-fuel ratio applies to quiescent mixtures of air and vapors of such fuels when ignited at the center of a closed bomb of sufficient capacity. This value was found to apply equally well to cracked and straight-run gasolines. The inference was drawn from the results that aside from volatility various kinds of hydrocarbon motor fuels do not differ appreciably in their ability to start an engine.

That important period of engine operation between the start and regular high-speed operation was dealt with in Mr. Eisinger's paper. More specifically, the investigation, another project of the Cooperative Fuel Research, was designed to provide information on the relative influence of speed range, carbureter characteristics, jacket-water temperature, intake-manifold temperature, carbureter adjustment, and the injection of an accelerating charge upon the acceleration performance of a given engine using the same fuel.

Preliminary tests were made with a four-cylinder truck engine, while in the main body of the investigation a six-cylinder passenger-car engine was used. To bring to the laboratory procedure conditions that the engine would have to meet if performing in a car on the road, the inertia due to the weight of the car was simulated by coupling to the end of the dynamometer shaft a steel disk or flywheel and a load equivalent to the wind and rolling resistance was imposed on the engine by the dynamometer. The test method consisted of developing a theoretical maximum-acceleration curve for the engine and comparing results obtained under various conditions with this.

Among the conclusions that seem to be justified by the data developed by the investigation are that acceleration is not affected by the temperature of the cylinder walls or the location of the accelerating jet, but is largely dependent on the temperature of the intake manifold, and that an accelerating charge ceases to improve acceleration only when the idling mixture is excessively rich. In his paper Mr. Eisinger also advanced a number of interesting speculations concerning the possible explanations of certain phenomena observed during the tests, dealing to some extent with the little-explored question of the behavior of fuel-air mixtures in engine manifolds.

The three papers noted above will be printed in an early issue of THE JOURNAL.

HUMOR POINTS SERIOUS LESSONS

Chairman Wilson vouched in advance for Dr. Schmidt's reputation as a humorist, which the latter fully sustained in his paper, which is printed elsewhere in this issue of THE JOURNAL. His address dropped neatly into the category of sugar-coated pills of wisdom. While he aroused much laughter by detailing some of the pertinent and impertinent items included in specifications for petroleum lubricants, he commanded a respectful hearing for his serious exposition of the principles which should underlie specification writing. First, he said, specifications should describe fully the desired product, so that the manufacturer can supply it. Second, they should make it possible for the purchaser to determine whether the desired product has been supplied. Special emphasis was laid on the dictum that all clauses in specifications must be pertinent and must be enforceable.

Mr. Spicer's paper described recent tests conducted in the course of several years' investigation on the torsional strength of multiple-splined shafts. It is also printed in full in this issue of THE JOURNAL. He summarized his findings by pointing out that while the elastic-limit of the small round shaft is substantially greater than the elastic-limit of the splined shaft, for material of the ductility of the specimens used in the experiments described, the ultimate tensile-strength of the splined shaft is much greater than that of the small round shaft. This difference, he said, would be proportionately less if the shafts were made harder so that the elastic-limit more nearly approached the ultimate tensile-strength.

Two points of especial interest were covered in the discussion of the papers, the necessity of research in other fields of the automotive industry besides that of engineering and the decreasing cost and increasing efficiency of individual transportation.

OILING AND VALVE-SPRINGS STUDIED

Lubrication and Valve-Spring Surge Treated Thoroughly at Engine Session

Two important subjects were presented for discussion at the Engine Session that was held on the afternoon of Friday, May 27. S. W. Sparrow and Donald B. Brooks, both of the Studebaker Corporation of America, prepared the paper on Oil-Flow through Crankshaft and Connecting-Rod Bearings. W. T. Donkin and H. H. Clark, of the Cleveland Wire Spring Co., were the authors of the paper on Valve-Spring Surge, printed in full elsewhere in this issue. Past-President H.

L. Horning, president and general manager of the Waukesha Motor Co., was chairman.

Oil-Flow Through Bearings

Factors which govern the flow of lubricant through the crankshaft and connecting-rod bearings were analyzed by the authors of the paper on the foregoing subject. The apparatus for measuring oil-flow was described, and the fact that it permits measurement under operating conditions was brought out. Enumeration of the results obtained by increasing the clearances on main and on connecting-rod bearings was made, and the influence of engine-speed was treated. Centrifugal force was shown to have a major influence on oil-flow at high speeds, but it was pointed out that the magnitude of this influence can be controlled to a considerable extent by the radial location of the oil-hole in the crankpin. The fact that the effect of changes in pressure varies with differences in engine-speed was commented upon, and a possible explanation for this condition was advanced. Some results which at first appeared surprising were obtained in static tests in which oil-flow was measured at various crank-angles.

It was stated that the measurements quoted in the paper were obtained by applying oil under pressure of known value to the bearing or bearings under test, and at the same time measuring volumetrically the amount of oil-flow. The apparatus used consisted of a tank constructed of 3 ft. of 4-in. pipe capped at each end and supplied with a gage glass, a filling pipe, a pressure gage, and suitable valves and piping for controlling the pressure of the compressed air which served to force the oil through ¼-in. tubing to the engine under test. At the engine, a pressure gage was attached to the feed-line to show the actual delivery pressure of the oil. When the oil-flow to only one bearing was being studied, the other bearings were fed in the normal manner, the oil-distributor pipe being blanked-off to the bearing under test. When the oil-flow to all bearings was being measured, the oil-pump was disconnected and the bearings were supplied directly from the metering tank. The gage glass of the metering tank was graduated into equal calibrated sections, and measurements of oil-flow were made by noting from a stop-watch the time required for the oil-level in the gage glass to fall past one or more of these graduations. In conclusion, it was stated that the results constitute data not readily available elsewhere relative to the influence of speed and pressure upon oil-flow, and that this method is a satisfactory one for measuring oil-flow to an individual bearing under operating conditions.

Chairman and Speakers at Engine Session
H. L. Horning Was Chairman of Engine Session and S. W. Sparrow (Right) and D. B. Brooks (Left) Discussed Oil-Flow through Bearings

W. T. Donkin and H. H. Clark Who Discussed Valve-Spring Surge

In the discussion following the paper, experiences with regard to the location of an oil-hole in the connecting-rod to provide for proper lubrication were related by E. S. Marks, Ralph R. Teetor and Lee W. Oldfield. Doubt seemed to exist that such an oil-hole is efficacious. In reply to a question from Chairman Horning in regard to the maximum pressure that may build up in the oil-film in a bearing, D. P. Barnard, 4th, mentioned tests made on an experimental bearing in which a pressure of 8000 lb. per sq. in. was carried without rupturing the oil-film. That load was sufficient, he said, to squeeze the babbitt out beyond the edge of the shoe; yet, at no time was there evidence of scoring or scratching, or did the performance of the bearing indicate that any metal-to-metal contact existed. He said that the tests referred to were reported in a publication of the Kingsbury Machine Works. In his opinion no doubt exists that somewhere within that bearing-block the pressure was two or three times 8000 lb. per sq. in. Dr. H. C. Dickinson stated that the maximum pressure in a journal bearing may reach five times the average value.

With regard to oil-grooves in the connecting-rod bearing and in reply to a query from Chairman Horning, Mr. Sparrow said that experiments had been made by the Bureau of Standards with bearings in which the presence or absence of a lubricating film was indicated by an electric light, the circuit of which was made and broken by the oil-film. A number of bearings were tested under conditions of speed and load that could be controlled accurately. Each one of the bearings was then grooved in one manner or another. In Mr. Sparrow's opinion, there may be a need for some type of groove to collect the dirt that enters the bearing; that is, there may be a need for some sort of flushing action. W. R. Strickland called attention to the difficulty of getting oil into the bearings on new cars and on engines that have been idle for some time so that the oil in the bearings has run out, saying that oil-grooves are often installed to remedy this trouble. The subjects of proper oil-pressure, over-oiling and the quantity of oil needed for adequate lubrication were debated during the remainder of the discussion.

Discussion on Valve-Spring Surge

A very interesting and instructive feature of the discussion following the presentation of the paper on Valve-Spring

Surge was the exhibition of slowed-down motion-pictures of an ordinary valve-spring and of a valve-spring redesigned to minimize valve-spring surge, while these springs were being operated at engine-speeds of from 700 to 1500 r. p. m. Comparisons of the amount of surge of each spring at any given engine-speed were thus made possible, and the degree to which valve-spring surge at any given engine-speed had been minimized in the redesigned spring was made evident.

Chairman Horning emphasized how complicated the problem of valve-spring surge is because of the fact that one set of periodic vibrations is superimposed on another set of similar vibrations. Further, the entire mechanism is elastic, and this adds to the complication.

In reply to a query as to how closely the periodic vibrations obtained from tests checked with the values calculated from Ricardo's formula, Mr. Donkin said that the observed values check very closely with the calculated. As to repeated characteristic breaks in a spring, say in the second, third or fourth coil of a spring that is designed to be well within reasonable limits of stress and whether such breaks are caused by surging action, Mr. Donkin stated that such breakage is due to the over-stressed condition at the point in question and that this over-stressed condition undoubtedly is caused by the surging action. He said further that one way to overcome the difficulty is to increase the static stress in the spring; but, increasing the static stress does not always increase the actual stress and it is the actual stress that counts, not the static stress as calculated from the formula.

LATEST FEATURES OF BRAKING-SYSTEMS

Internal Brakes, Brake-Lining Tests, Brake-Testing and Adjusting Analyzed

Satisfactory performance of braking-systems may be said to have been the general subject that held the attention of the members and guests who attended the Brake Session which was held on Saturday morning, May 28. The paper on Internal Brakes, by H. D. Church, director of engineering for the White Motor Co., was read by F. G. Alborn, assistant chief engineer of that company. Brake-Lining Tests was the subject presented by S. von Ammon, of the Bureau of Standards, and the paper was in the nature of a progress report on tests conducted by the Bureau. In connection with this subject, supplementary prepared discussions were read; one was by H. D. Hukill, of the Westinghouse Air Brake Co., who outlined the results of tests made by his company, and the other was by A. M. Yocom, chief engineer of the Multibestos Co., the latter being illustrated with numerous lantern-slides indicative of the practice of that company. F. W. Parks, of the Cowdrey Brake Tester Organization, described the apparatus and methods for brake-testing and adjusting that are in use by his company. The papers by Messrs. Church and Parks are printed in full elsewhere in this issue. That by Mr. von Ammon will be published in a later issue, but a brief sketch indicating its scope is included herewith. G. A. Green, vice-president in charge of engineering for the Yellow Truck & Coach Mfg. Co., was chairman of the session.

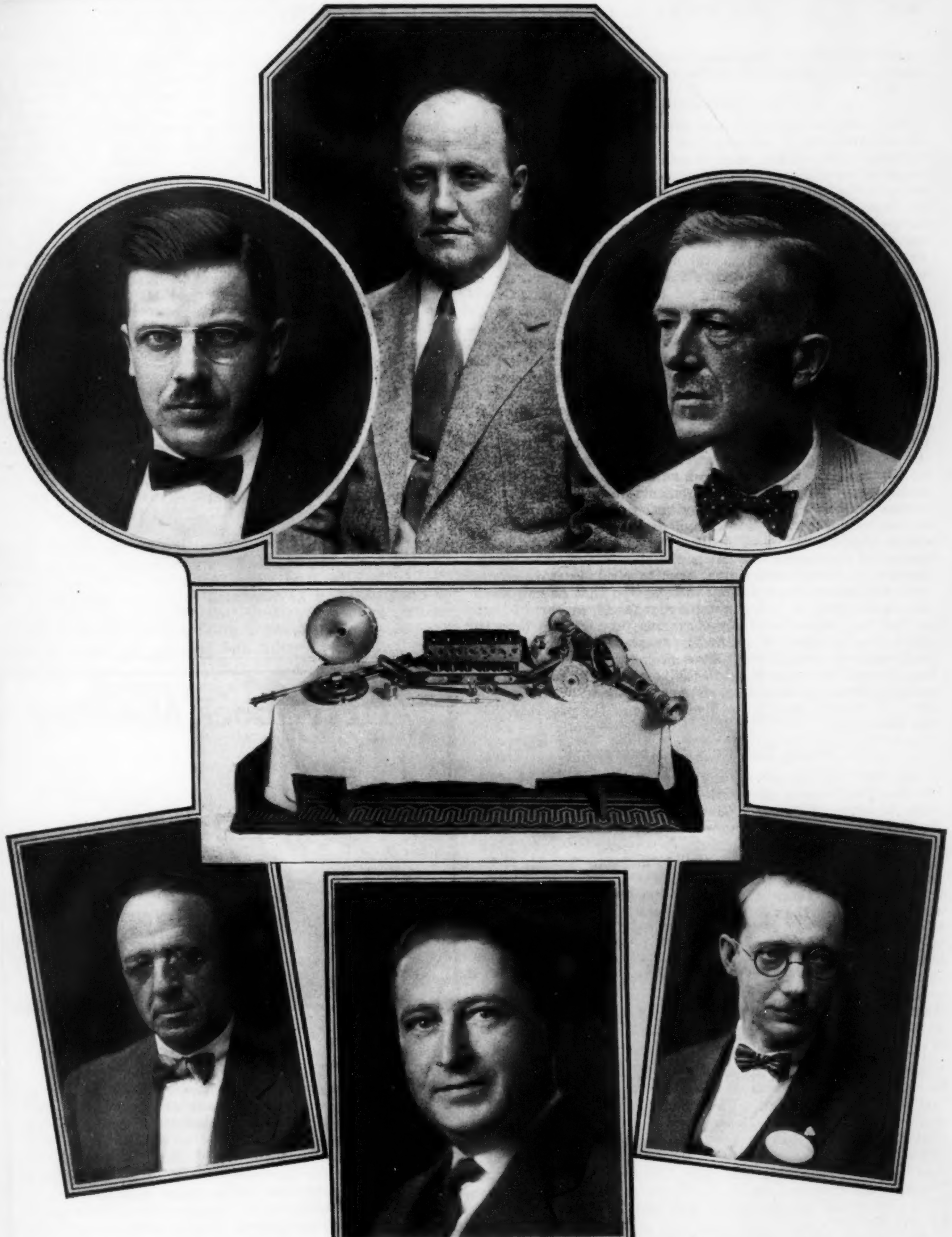
INTERNAL BRAKES

In commenting upon Mr. Church's paper, Mr. Hukill remarked that the tests of braking equipment in service made by his company bear out the results mentioned by Mr. Church as having been proved by road-tests. He said also that it has been found most important to use rigid supports of ample cross-section for the anchor-pins and camshafts, and that these be located correctly and accurately. Brake-drum surface must be perfectly concentric with the hub-bore and, where drum and hub form a two-piece unit, the surface of the drum should be finished after the hub and the drum are assembled, centering from the hub-bore mounted on a suitable mandrel. Rotation of the cam during brake application should be in the same direction as that of the brake-drum rotation.

As described by Mr. Hukill, the heat-dissipating properties of the all-metal brake were demonstrated thoroughly in a series of tests made in August, 1926, in the Allegheny Mountains, with a Model 50-B four-cylinder 29-passenger White motorcoach having standard factory brake-equipment; that is, air-operated all-metal brakes on the rear wheels only, the tire equipment being Goodyear 36 x 8.25-in. dual balloon-tires mounted on 20-in. rims. The vehicle, loaded to 17,000 lb., was coasted with gears in neutral at a constant speed of 15 m. p. h. down an approximately uniform grade of 8¼ per cent that was 13,000 ft. long. The speed was controlled entirely by the rear-wheel all-metal brakes. The maximum brake-drum temperature encountered on any run was 625 deg. fahr., measured by calibrated thermocouples located at the center of the brake-drum face ⅛ in. below the friction surface and read 30 sec. after stopping at the foot of the grade. Maximum tire-temperature was 145 deg. fahr., as determined from thermocouples located between the tire-bead and the metal tire-rim on the inner tire, readings being taken from 15 to 20 min. after the end of the run. Maximum hub-temperature was 145 deg. fahr., determined in the same manner, and the maximum axle-housing temperature was 125 deg. fahr., taken at a point under the spring-pad. Brake-shoes attaining a temperature slightly higher than that of the brake-drum, expanded at approximately the same rate as did the brake-drums; hence, there was no "run-out" of the brake at any time, brake-chamber travel remaining constant under all conditions.

Problems of brake maintenance were discussed by Mr. Yocom, the information offered being based on contacts established with the various car and brake service-stations that undertake brake-maintenance of all types of passenger-cars, motorcoaches and motor-trucks, and on personal tests. Among the points brought out were the following: Brake-lining seems to be one of the most highly stressed parts of a motor-vehicle, and any change from the original brake-lining surface caused by the entrance of foreign material is likely to cause wide variations in brake performance. After brakes and brake-linings have been tested with apparatus and instruments such as are described by Messrs. von Ammon and Parks, the speaker said, numerous factors are apparent that may cause the brake-maintenence troubles such as are reported from most brake service-stations, such as noise, lack of holding ability or glazing, grabbing, and the like. Brake-lining in contact with a brake-drum constitutes a bearing and, to prevent this so-called bearing from being noisy it is necessary to use proper brake-lining materials and saturant and to heat-treat the combination so that the saturant will not soften or ooze at practicable operating temperature. Mr. Yocom then went into detail, citing data resulting from tests and explaining the various charts and illustrations he exhibited.

During the oral discussion that followed, Chairman Green asked why cast-iron brake-drums are used only with fabric brake-lining and steel brake-drums only with all-metal brake-shoes. Mr. Alborn replied that fabric brake-lining picks off fewer particles of metal from cast iron than it does from steel, because the cast-iron brake-drums used have a very high combined-carbon content, with the graphitic carbon present in the form of small flakes interlaced in a peculiar manner. The cast iron used is very close-grained. Steel has proved to be the best material for brake-drums to which all-metal brake-shoes are applied. Mr. Alborn said further that about the same mileage is being obtained from the all-metal "throw-away" type of brake-shoe as with the fabric-lined brake-shoe; for say one stop per mile, one can expect about 25,000 miles of service from the brakes. Further questions from Chairman Green elicited the information that, assuming five stops per mile, the all-metal throw-away type of brake-shoe will not cost materially more than does the high-grade brake-lining. A brake-drum will wear out two and even three sets of all-metal brake-shoes, according to Mr. Alborn's statement, since as much as a ¼-in. reduction in the brake-drum diameter is practicable before it becomes necessary to replace the brake-drum. Other details relative to the costs of all-metal brake-shoes and their application by air pressure, to the heating effect of the all-metal brake on



SPEAKERS AT THE BRAKE AND THE PASSENGER-CAR SESSIONS

F. G. Alborn (Upper Right) Presented H. D. Church's Paper on Internal Brakes, and F. W. Parks (Lower Left) Spoke at the Brake Session. E. W. Seaholm (Upper Center) Was Chairman of the Passenger-Car Session and M. C. Horine (Lower Right), D. P. Cartwright (Lower Center) and P. B. Jackson (Upper Left) Presented Papers. The Aluminum Parts Discussed by Mr. Jackson Were Exhibited in the Hotel Lobby

brake-shoe retracting-springs, brake-shoe dragging, and the like were too voluminous for inclusion in this report.

Brake-Lining Tests

Mr. von Ammon said that the object of his paper is to establish standard methods for tests of brake-linings, and referred to his earlier paper which was a report on the work done by the Bureau of Standards during 1921 in connection with the development of methods and equipment for tests of brake-linings.[1] He stated further that the early tests demonstrated wide differences in behavior of various materials marketed at that time and led the manufacturers to increase their experimental activities. Since that time, the demands on brake-linings have grown very much; on the other hand, the designer of brakes knows much more about the desirable features of design. Hence, the situation is changed somewhat. However, the manufacturer of brake-linings and the users of them both find much difficulty in determining the characteristics of brake-linings under the conditions to be met, as governed by the many phases of brake design, car design and operating conditions. Road-tests in which a brake-lining can give final account of itself under all conditions met in service result in data ranging all the way from the design of the braking-system to the conditions of the road and the influence of the latter on the former. Information of value on features of brake design as well as on the requirements to be met by brake-linings for best results with any brake can also be obtained by laboratory tests of brakes and of brake-linings combined either with an individual brake or with the entire braking-system of a given vehicle on its chassis. Finally, the manufacturer of brake-linings must turn to his laboratory equipment for testing brake-linings, as such, so that he can learn the explanation of every peculiarity found in service and so that he can continuously check his product and thus be enabled to maintain it as nearly as possible with absolute uniformity and reliability. Present laboratory test-methods have not yet been developed to the point where they aid both manufacturer and user in a manner wholly satisfactory, but Mr. von Ammon went on to give details of the progress that has been made.

Brake-Testing and Adjusting

Lack of time prevented any discussion of the papers by Messrs. von Ammon and Parks. Before adjourning the session, however, Chairman Green referred to the statement in Mr. Parks' paper to the effect that little attention has been paid by automotive engineers to stopping motor-vehicles, characterizing it as overdrawn. In Chairman Green's opinion, more time is spent by the engineers in the heavy-vehicle industry in experimental work and developments in connection with brakes than is spent on the other units.

LAST SESSION GOES BY DEFAULT

Three Excellent Papers Presented by Title Only Due to Early Departures

Departure for home of a majority of the members and guests on the early afternoon train of Saturday resulted in absence of an audience at the Passenger-Car Session, the last one of the meeting. Chairman E. W. Seaholm, chief engineer of the Cadillac Motor Car Co., therefore announced that the papers would be presented by title only and published in this and subsequent issues of The Journal. The first paper on the program, The Effect of Legislation on Design, was prepared by D. C. Fenner and M. C. Horine, of the International Motor Co., and was to have been read by Mr. Horine.

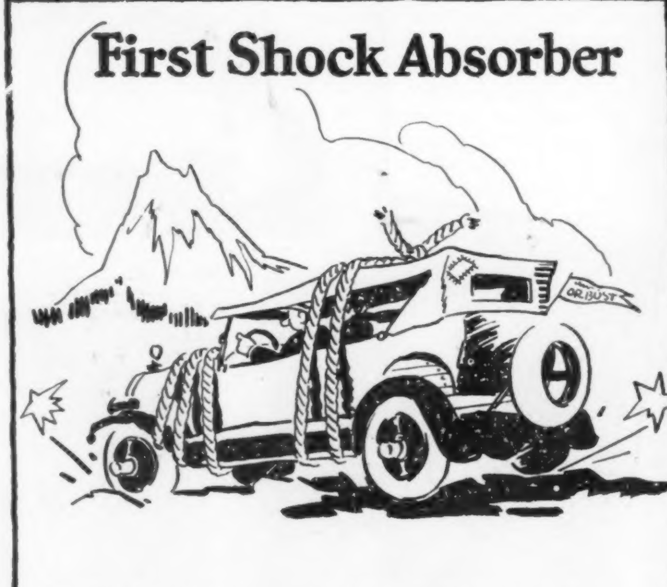
The second paper, Failures of Electrical Apparatus on the Road, prepared by D. P. Cartwright, of the North East Service, Inc., is printed in this issue of The Journal and covers a very important phase of servicing.

The third and last scheduled paper, An Experimental Development in Light-Weight Passenger-Car Design, by P. B. Jackson, of the Aluminum Co. of America, bears on a subject that is now of great trade interest and it is a matter of regret that it could not have beeen presented to a good audience and full discussion had upon it. In the circumstances it probably will be mimeographed and sent to a number of members known to be interested in the subject to elicit written discussion for publication later in connection with the paper.

How Legislation Affects Design

Granting the necessity of motor-vehicle legislation and regulation in the interest of public safety and preservation of the highways, D. C. Fenner and M. C. Horine reviewed in their paper the effects of some of the more important restrictions on passenger-car, motorcoach and motor-truck design. Legislative and regulatory machinery is slow to set in motion and, once started, is very difficult to arrest; it has acquired such momentum today that it is now the intimate concern of virtually all elements of the automotive industry. Legislative enactments, as a rule, have little effect on the development of automotive design, but their effects on the market for specific types of equipment are sometimes of great importance, as in the case of gross-weight restriction. Within recent times, regulation, as distinguished from legislation, has begun to exert an increasing direct influence on the design and construction of certain classes of motor-vehicle, such as the motorcoach and motor-truck.

Passenger-car design has been affected materially by one of the oldest legislative enactments relating to motor-vehicles. This is the almost universal basing of licensing or taxation on the horsepower as calculated on cylinder bore, which has resulted in long-stroke engines. Headlighting requirements have caused the industry a great deal of trouble because of their lack of uniformity and because, by reason of their



The original Shock Absorber was a crude affair. It was not invented in research laboratories but was conceived by the angry mind of George Thump in whose second-hand car the affiliation between body and chassis was extremely tenuous. In fact, upon more than one occasion George and the entire Thump family were mortified by having the body bounce completely off the chassis. "I'll fix her so's she'll stay fixed," gritted George the third time this happened. He tied the body securely on the chassis with the several tow ropes which came with the car. As a result, the car not only remained together but its riding qualities were decidedly improved.

[1] See The Journal, March, 1922, p. 153.

Two Cartoons from the Series "True Stories of

rigid specific provisions, they hinder solution of the problem on which engineers are working. With the advent of four-wheel brakes a number of makes of car have appeared in which a single set of four brakes is operated by two independent controls, which arrangement does not comply strictly with the legal requirement for two independent braking-systems. This situation exemplifies the need of drafting enactments and regulations in a form that specifies the results desired without specifying the precise means. Various organizations have undertaken to draft a uniform brake and brake-testing code to be submitted to the American Engineering Standards Committee to become a general standard.

Motorcoach and Truck Development Impeded

Unfortunately, much of the regulation relating to motorcoaches has been in the form of legislation, hence modification to keep pace with developments is difficult and slow. Six States permit a maximum gross weight of 28,000 lb., while two States limit the gross weight to 15,000 lb. Overall length is restricted to 28 ft. by two States, while three allow as much as 40 ft. Maximum width limitations vary from 84 to 102 in., and maximum height from 12 to 13 ft. New Jersey limits body length to 24 ft., which prevents realization of the advantages of a recent motorcoach development that, according to the authors, contemplates a motorcoach in which the powerplant is housed within the body, so that the body occupies the full length of the vehicle. Motorcoach designers are forced to give careful study to legislation and regulations in the various States in all their design work and in the selection of motorcoach equipment, and the lack of uniformity has been a severe handicap on design development.

The motor-truck, however, suffers most from legal restrictions, it is asserted, as these have had a more specialized and profound effect on the economic fundamentals of transportation by truck. The most serious effect has been to discourage the building of the most economical types of transport vehicles; that is, large-capacity heavy-duty trucks. Nearly all States impose limitations of gross weight, vehicle weight or carrying capacity, with the obvious purpose of forcing operators to use light vehicles. It has been definitely established, however, as a result of more than 8 years of research and experimenting, that gross weight is by no means a fair measure of the road-destructive potentialities of the vehicle. A report of the Bureau of Public Roads is cited as summarizing its conclusions from a series of impact tests with the statement that the impact reaction of a truck on the road depends on wheel load, truck speed, tire equipment and road roughness. Even a truck of moderate weight, when operated at excessive speed and having a large unsprung weight, stiff springs and worn tires, may produce more destructive impact than a truck of much greater gross weight in which these other factors are more favorable.

One serious effect of arbitrary gross-weight limitation is that it encourages the purchase and overloading of unduly light types of chassis so that greater pay-loads can be carried. In limiting unit loads by legislation the fact seems to have been overlooked that such restriction does not materially affect the total quantity of goods hauled but that the effect is to increase the number of vehicles and that this increases the tare weight and traffic congestion, while at the same time adding a burden of increased transportation cost upon the public. Weight limitations have had a profound influence on truck design and have been largely instrumental in bringing about the development of six-wheel vehicles, tractor and semi-trailer combinations, and of pneumatic-tired truck equipment.

In conclusion the authors suggested that the engineers can do much to assist the industry in adapting itself to the changing conditions brought about by legislative activity by cooperating with some of the dozen or more organizations that are striving to bring the light of facts and some reasoning to bear upon the problems of motor-vehicle regulation.

A Light-Weight Aluminum Car

Details of the construction of an experimental light-weight large six-cylinder car are given in the paper by P. B. Jackson, who displayed parts of the car on a table in the hotel, as shown in an accompanying photograph. This car, which has a 133-in. wheelbase of standard tread and a cast-aluminum body weighing as much as a body of conventional construction and equal dimensions, weighs only 2985 lb. fully equipped and with full supplies of gasoline, oil and water. The weight reduction is all accomplished in the chassis, by the substitution of aluminum and aluminum alloys for steel and cast and malleable iron. The American car of today is a relatively large and heavy vehicle, and economic and other factors point to continued demand for the large car in this Country for some years to come, asserts the author, hence weight saving is of considerable significance. Although aluminum has been used for various parts almost from the inception of the automobile, a car design replete in the use of aluminum could not have been contemplated except for marked improvement in recent years in the physical characteristics of aluminum alloys and the development and perfecting of fabricating processes such as forging and extrusion.

Whereas aluminum alloys have a modulus of elasticity of a nominal value of only 10,000,000 lb. per sq. in. as against an average of 30,000,000 lb. for steel, stress and rigidity usually are the two major factors investigated in any design. Stress involves only area and the moment of inertia. To equal the rigidity of a steel bar 1.000 in. square, an aluminum bar need be increased to only 1.316 in. The stress in bending an aluminum bar of this dimension is reduced to 7900 lb. per sq. in., or slightly more than 56 per cent, hence the steel bar is heavier by 62 per cent than an aluminum bar of equal rigidity, and a 19-per cent increase of cross-section provides stiffness equal to that of cast iron and bronze. These facts, asserts the author, should eliminate any question of the

Rearview Mirror

The above illustration is an historically accurate representation of how the Rearview Mirror accidentally was discovered. The family of P. O. T. Whiffletree was engaged in the annual Spring Moving. Among the family lares and penates piled on the moving truck was Aunt Agatha Whiffletree's old bureau. Mrs. Whiffletree, riding the load as the truck sped along, discerned in the bureau mirror the pursuing figure of John W. Law. She dropped a kitchen chair under Mr. Law's front wheel, which, so far as Mrs. Whiffletree was concerned, ended the episode. The Rearview Mirror since has been developed into an accessory which has saved thousands of other motorists from Mr. Law's clutches.

Auto Inventions" That Appeared in the *Daily SAE*

mechanical adaptability of aluminum as a structural material.

Basic formulas for car performance all show that weight is a prominent factor. Those for acceleration and deceleration involve force and mass; acceleration is inversely proportional to weight, and in deceleration the force required for retardation is directly proportional to weight. Hill-climbing ability also is a direct function of weight. Maximum speed does not involve weight as a prominent function, since at speeds of more than 50 m.p.h. wind resistance becomes the major factor, yet the light-weight car should have an advantage of a few more miles per hour than a heavy one.

The measure of economy is not in direct ratio to weight, but the light car has a distinct advantage in this respect.

Aluminum Proved Good Substitute for Steel

Substitution of aluminum for cast iron or steel results in a saving of about 50 per cent in weight of each part in which the substitution is made, it is asserted, but even so the price differential per piece is unfavorable to aluminum; however, optimists feel that, with redesign of machine-tool equipment, the material-price differential will disappear. Credit for the original work that preceded the design of the six-cylinder car referred to herein is given to Lawrence H. T. Pomeroy, who came to this Country in 1919. After affiliating himself with the Aluminum Co. of America, he built four small four-cylinder aluminum cars, of which three are still running and the fourth was reconstructed to accommodate a six-cylinder engine. The first of the four has been driven about 200,000 miles and still retains outstanding acceleration characteristics, according to Mr. Jackson. All these cars demonstrate forcibly the satisfactory substitution of strong aluminum alloys for steel.

The exhibit in the hotel lobby included the six-cylinder engine-block, weighing about 40 lb.; a forged I-beam-section front axle weighing 21 lb., or slightly more than 50 per cent less than steel axles for cars of the same size as the experimental car; a 12-in. clutch in which a saving of 7 lb. has been effected; a brake-shoe assembly of light weight having the added advantage of neutralizing expansion of the brake drum due to the high coefficient of expansion of the aluminum; and a propeller shaft. Many interesting features of the various parts are described. The complete engine assembly, with standard carbureter and electrical equipment, weighs 452 lb., or slightly less than 6 lb. per hp. The rear axle, complete with propeller-shaft, torque tube, wheels, brakes, rims and tires, weighs 369 lb. The chassis frame is of conventional design, made from the dies for the Pierce-Arrow Series 80 model, and is of strong aluminum alloy 3/16 in. thick. Aside from the decreased weight resulting from the use of light metal, the various component parts present unique features in design. In the engine, no parts are made of aluminum that have not been used heretofore on production jobs in this Country.

SESSIONS WELL ANNOUNCED

Two innovations were used in announcing the technical sessions at the Summer Meeting. Through the courtesy of F. G. Diffin, the Meetings Committee was able to use one of the Longsigns being introduced by his company to announce the speakers and subjects at the technical sessions and the various sports. The Longsign was placed in a corner of the dining room where it could be seen by everybody three times a day. The sign was 6 ft. long and 8 in. high, the face being banked with over 500 miniature lamps which, by a clever control mechanism involving the use of a perforated tape carrying the message to be announced and a mercury bath, permitted the message to flash across the sign from right to left.

In addition to the sign, aerial bombs were used, two being fired 15 min. before each session and one 5 min. before.

PRODUCTION ENGINEERING

(Concluded from p. 714)

partment and incorporated in the Research Committee's program. Among the suggested subjects received were:

- Standard names for chucks and arbors that will indicate their sizes and capacities
- Methods for determining a day's work and adequate compensation therefor
- Manufacturing expense analysis
- Shop job specifications
- Machineability of metals
- Relation of inspection and payment plan of production
- Standards and means for making comparative measurements of noise and vibration and combinations of them in machines, machine units and places regarding which it is necessary to have such data
- Surfacers, including oil and lead base as well as pyroxylin-finish paints and their applications
- Relative value of diamond and steel tools for the fly method of finishing and economic amounts of metal that can be removed by them
- Centered and centerless grinding of pistons
- Finishing small holes by honing, including the Hutto system

Of the subjects suggested, the collection of data on the machinability of metals has already been started by the Research Department of the Society and measurement of noise and vibration, surfacers and the fly method of finishing are considered as being the most promising for early study.

Although the Production Advisory Committee is represented unofficially on the Research Committee by W. G. Careins who is also a member of the Production Division of the Standards Committee, each member of the Production Advisory Committee should keep in touch with the Research Department and the Research Committee in order to assist in the studies that may be made of these and other subjects of interest to production engineers and executives. The work of the Research Committee in this connection will be reviewed in the Production Engineering Department of later issues of The Journal.

Applicants *for* Membership

The applications for membership received between April 15 and May 14, 1927, are given below. The members of of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

ABBOTT, PARKER B., manager of logging division, E. H. Edwards Co., *San Francisco.*

ACKERMAN, PAUL C., service engineer, Timken Roller Bearing Co., *Canton, Ohio.*

ARTHUR, JAMES L., ignition engineer, Delco-Remy Corporation, *Anderson, Ind.*

BARKER, THOMAS H., manager, Colyear Motor Sales Co., *Spokane, Wash.*

BARR, DUGALD M., development manager, A. Schrader's Son, Inc., *Brooklyn, N. Y.*

BLACKWELL, E. E., sales engineer, Morse Chain Co., *Detroit.*

BLANCHARD, E. P., engineer, Bullard Machine Tool Co., *Bridgeport, Conn.*

BITTING, GEORGE L., director of sales, Bunting Brass & Bronze Co., *Toledo.*

BOUVY, CHRIS. H., mechanical engineer, Cadillac Motor Car Co., *Detroit.*

BRADEN, ELMER A., engineer, Monarch Tractors Corporation, *Springfield, Ill.*

BRETZLAFF, W. HERBERT, sales manager, John W. Brown Mfg. Co., *Columbus, Ohio.*

CAHILL, GEORGE A., president, Franklin-Cahill Motors, Inc., *Jamaica, N. Y.*

CAPPA, GIULIO CESARE, mechanical engineer, Studio Technico, *Turin, Italy.*

CHANDLER, WILLIAM A., mechanical inspector, New York, New Haven & Hartford Railroad, *Danbury, Conn.*

COLLINS, G. C., engineer, Frost Gear & Forge Co., *Jackson, Mich.*

COOK, FRANZ W., test assistant, Chevrolet Motor Car Co., *Detroit.*

DAVIS, GORDON S., manufacturing and sales, Davis Brake Co., *Philadelphia.*

DUBY, JOHN F., manufacturer, *Mattapan, Mass.*

EATON, LEON S., teacher, University of the Philippines, *Manila, P. I.*

EKDAHL, CHARLES B., chief tool engineer, Pierce-Arrow Motor Car Co., *Buffalo.*

FAITH, PHIL C., service representative, Yellow Truck & Coach Mfg. Co., *Chicago.*

FERGUSON, FRED G., vice-president, Simplex Piston Ring Co. of America, *Cleveland.*

FETCH, WILLIAM LLOYD, salesman, Manhattan Rubber Mfg. Co., *Passaic, N. J.*

FOSTER, F. J., engineering representative for production, Chandler-Cleveland Motors Corporation, *Cleveland.*

FRENCH, J. T., lubrication engineer and assistant manager of lubricating department of Richfield Oil Co. of California, *Los Angeles.*

FUNSTON, WILLIAM H., JR., sales representative, Firestone Steel Products Co., *Akron, Ohio.*

GIER, FRANK C., superintendent of repair shops, Consolidated Gas & Electric Co., *Baltimore.*

HAIGHLER, EDMUND DERBY, student, Harvard Engineering School, *Cambridge, Mass.*

HAMMEL, W. F., production, Marmon Motor Car Co., *Indianapolis.*

HAMMOCK, JIM D., student, University of Washington, *Seattle.*

HARDER, DELMAR S., director of standards department, Durant Motor Co. of New Jersey, *Elizabeth, N. J.*

HEIL, WILLIAM H., chief engineer, Durwyllan Co., Inc., *Paterson, N. J.*

JOHNSON, WILBER M., automotive lighting specialist, National Lamp Works of General Electric Co., Nela Park, *Cleveland.*

JOHNSTON, WILLARD G., general shop foreman, Western States Gas & Electric Co., *Stockton, Cal.*

JONES, A. M., engineer, Willis-Jones Machinery Co., Inc., *Seattle.*

KALB, WARREN C., special engineer, National Carbon Co., Inc., *Cleveland.*

KANE, GEORGE E., superintendent of motor vehicles, Van Sciver Corporation, *Philadelphia.*

LEWIS, THOMAS WEBER, special representative, International Harvester Co. of America, *San Francisco.*

LIGHT, R. W., metallurgy and sales, Jones & Laughlin Steel Corporation, *Pittsburgh.*

LUCY, BRIAN, draftsman, Yellow Truck & Coach Mfg. Co., *Pontiac, Mich.*

MCCARTHY, J. P., factory manager, Durant Motor Co. of New Jersey, *Elizabeth, N. J.*

MCVEY, SANDY, service manager, W. H. Lee, Ltd., *Toronto, Ont., Canada.*

MELLENEY, H. C., office manager, Kelly-Springfield Tire Co., *New York City.*

MIZER, JOSEPH J., chief engineer, Walker Mfg. Co., *Racine, Wis.*

MOONEY, RAYMOND, secretary, Roach-Appleton Mfg. Co., *Chicago.*

MOORE, WILLIAM J., vice-president, Sheet Aluminum Corporation, *Detroit.*

NENKE, R. O., branch manager, Gardner Motor Co., Inc., *St. Louis.*

NIEDERLE, LUBOR J., sales engineer of motor-cars, Skoda Works, Ltd., *Prague, Pilsen, Czechoslovakia.*

PARKER, LESLIE O., mechanical engineer, Delco-Remy Corporation, *Anderson, Ind.*

PICKLES, FRANK, tool designer, Dodge Bros., *Detroit.*

PIERSON, ROBERT M., patent counsel, B. F. Goodrich Co., *Akron, Ohio.*

RAUTENSTRAUCH, WALTER, president, Splitdorf-Bethlehem Electric Co., *Newark, N. J.*

RECORDS, CHESTER E., sales engineer, Layne-Ohio Co., *Columbus, Ohio.*

RENDEL, T. B., research engineer, Roxana Petroleum Corporation, *Wood River, Ill.*

RENTZ, JAMES F., tool designer and draftsman, Lycoming Mfg. Co., *Williamsport, Pa.*

RICHTER, VICTOR, tester, Richter News Co., *Long Island City, N. Y.*

ROACH, J. C., sales engineer, Hyatt Roller Bearing Co., *Detroit.*

SALAMON, MICHAEL, sub foreman, International Motor Co., *Plainfield, N. J.*

SASAKI, HIROSHI, student, University of Utah, *Salt Lake City, Utah.*

SHEA, J. B., sales manager, Firestone Tire & Rubber Co., *Akron, Ohio.*

SHREINER, R. W., president, General Automotive Supply Co., *Harrisburg, Pa.*

SLUSSER, CLIFTON, vice-president and factory manager, Goodyear Tire & Rubber Co., *Akron, Ohio.*

SMITH, F. ARTHUR, chief engineer, Oakes Co., *Indianapolis.*

SMITH, FRANK D., JR., draftsman, A. C. Spark Plug Co., *Flint, Mich.*

SMITH, HARRY L., JR., sales manager, Aluminum Co. of America, PITTSBURGH.

STEINBRUGGE, HERMAN, vice-president, Weymann American Body Co., *Indianapolis.*

SWENSON, ANDREW S., Swenson Motor Co., *Wichita, Kan.*

TEMPLETON, LEE, president, Lee Motor Co., *Norristown, Pa.*

VAHRENHOLD, GEORGE C., engineer, Wagner Electric Corporation, *St. Louis.*

WARD, WARREN L., assistant sales manager, Russell, Burdsall & Ward Bolt & Nut Co., *Port Chester, N. Y.*

WATERBURY, R. J., chief engineer, Central Mfg. Co., *Connersville, Ind.*

WEYMOUTH, ALBERT HENRY, automotive engineer, Vacuum Oil Co. Proprietary Ltd., *Melbourne, Victoria, Australia.*

WHITAKER, JOHN TAYLOR, automotive engineer, Tide Water Oil Sales Corporation, *Detroit.*

WHITE, JOSEPH B., general service manager, Package Car Corporation, *Chicago.*

WINSLOW, WILLIAM V., assistant to general manager, General Motors Export Co., *New York City.*

YAGLE, HARRY A., assistant sales manager, Yellow Truck & Coach Mfg. Co., *Chicago.*

YOUNG, A. J., automotive sales engineer, Tide Water Oil Sales Corporation, *Boston.*

YOUNG, CHARLES D., service manager, Strang Garage Co., *Colorado Springs, Colo.*

ZIERER, WALLACE E., Marmon Motor Car Co., *Indianapolis.*

ZIMMERLI, FRANZ PERRINE, chief engineer, Barnes-Gibson-Raymond, Inc., *Detroit.*

Applicants *Qualified*

The following applicants have qualified for admission to the Society between April 9 and May 10, 1927. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (S M) Service Member; (F M) Foreign Member.

ARNOLDY, JOHN M. (A) vice-president and manager, Magneto Sales & Service Co., 1356 South Grand Avenue, *Los Angeles.*

ASKE, IRVING E. (A) general manager, As-Ke Fuemer Co., 2921 Stevens Avenue, *Minneapolis.*

BALLANTINE, NOTEN D. (A) assistant to president, Seaboard Air Line Railway, Baltimore; (mail) 613 Hopkins Apartment.

BARTHOLOMEW, EARL (M) head of automotive department, Ethyl Gasoline Corporation, New York City; (mail) 198 Seminary Avenue, *Yonkers, N. Y.*

BOEHM, A. BRUCE (M) lubrication engineer, Standard Oil Co. of New Jersey, New York City; (mail) 22 South Munn Avenue, *East Orange, N. J.*

BRAND, CHARLES LEEF (A) vice-president and Eastern sales manager, Davis Welding & Mfg. Co., 103 Park Avenue, *New York City.*

BUCHANAN, F. C. (A) director of sales, Columbian Steel Tank Co., 1509 West 12th Street, *Kansas City, Mo.*

BUSSEY, C. G. (M) garage superintendent, Union Oil Co. of California, *Los Angeles;* (mail) 2518 West 15th Street.

CARLSON, ALBEN F. (M) assistant body engineer, Pierce-Arrow Motor Car Co., 1695 Elmwood Avenue, *Buffalo.*

CHAFEE, JOHN S. (A) assistant secretary, Brown & Sharpe Mfg. Co., P. O. No. Box 1385, *Providence, R. I.*

CHANDLER, W. G. (M) superintendent of transportation, Brooklyn Edison Co., Inc., *Brooklyn, N. Y.;* (mail) 328 Sterling Place.

CHRISTENSON, L. W. (A) sales engineer, Cleveland Graphite Bronze Co., 880 East 72nd Street, *Cleveland.*

COOK, BYRON G. (M) automotive instructor, East Technical High School, Cleveland; (mail) 1444 Lakeland Avenue, *Lakewood, Ohio.*

DAMMANN, WILL (A) president, Bear Mfg. Co., *Rock Island, Ill.;* (mail) 2030 Fifth Avenue.

DEHART, CHARLES R., JR. (J) engineering department, Spicer Mfg. Corporation, South Plainfield, N. J.; (mail) Front Street, *Scotch Plains, N. J.*

DELL, GERALD F. (A) superintendent of railway traffic and engineering, Scott Bros., Inc., Water and Dickinson Streets, *Philadelphia.*

DOWSETT, FRED R. (M) general manager, Fuller & Sons Mfg. Co., 1419 North Pitcher Street, *Kalamazoo, Mich.*

EMMERT, RODGER J. (M) factory manager, Delco-Remy Corporation, 329 East First Street, *Dayton, Ohio.*

FAHRNEY, E. H. (M.) president, Universal Motor Co., Oshkosh, Wis.; (mail) 231 South LaSalle Street, *Chicago.*

FINN, WILLIAM J. (J) engineer, Maxmoor Laboratory, 514 Ferry Street, *Newark, N. J.*

FISHER, ALFRED J. (M) vice-president in charge of engineering, Fisher Body Corporation, division of General Motors Corporation, General Motors Building, *Detroit.*

FOWLER, L. E. (M) design engineer, Lycoming Mfg. Co., *Williamsport, Pa.*

FREEDLANDER, A. L. (M) factory manager, Dayton Rubber Mfg. Co., Riverview Avenue, *Dayton, Ohio.*

FREEMAN, SPENCER (A) consulting automotive engineer, 63 Kenilworth Court, Putney, *London S. W. 15, England.*

FROST, JACK (A) sales manager, Willis-Jones Machinery Co., Inc., Seattle; (mail) 3962 Second Boulevard, *Detroit.*

FURUBOM, HENRY (J) draftsman, De La Vergne Machine Co., *New York City;* (mail) c/o E. J. Herbert, 755 East 168th Street.

GAMBLE, WILLIAM J., JR. (M) secretary, treasurer and manager, Vulcan Steam Forging Co., *Buffalo;* (mail) 54 Claremont Avenue.

GORBUTT, S. B. (M) chief engineer, Willamette Iron & Steel Works, *Portland, Ore.;* (mail) 532 East 25th Street, North.

GREENE, MARIUS, DR. (A) technical advisor, Commuters Air Transport, Inc., 20 West 34th Street, *New York City.*

HADAWAY, W. S. (M) engineer, Edison Lamp Works of the General Electric Co., *Harrison, N. J.*

HURTH, FRITZ (F M) mechanical engineer, Maschinen und Zahnradfabrik Carl Hurth, *Munich, Germany.*

HUSSONG, PAUL (A) service manager, Greer College of Automotive Engineering, *Chicago;* (mail) 1436 Roscoe Street.

KANE, M. J. (A) owner and manager of automotive repair shop, *Seattle;* (mail) 6325 20th Avenue, North East.

KIELY, THOMAS J. (A) designer, checker and assistant chief draftsman, American Bosch Magneto Corporation, *Springfield, Mass.;* (mail) Young Men's Christian Association.

LEWIS, L. V. (M) superintendent motorcoach maintenance, Public Service Transportation Co., Irvington, N. J.; (mail) 249 Hillside Avenue, *Hillside, N. J.*

MAGEE, RICHARD A. (A) motor products sales department, Texas Co., *Boston;* (mail) 337 Commonwealth Avenue.

MASON, GEORGE E. (J) test engineer, Multibestos Co., *Walpole, Mass.;* (mail) 128 Common Street.

MILLER, C. R. (M) consulting engineer, White Star Refining Co., *Detroit;* (mail) 5959 Avery Avenue.

NEUDECK, JOSEPH E. (A) dynamometer technician, Maxmoor Laboratory, Newark, N. J.; (mail) 38 Avon Avenue, *Irvington, N. J.*

OLSON, ARVID C. (A) instructor of automotive mechanics, Eveleth Manual Training School, *Eveleth, Minn.;* (mail) 622 Jones Street.

PEARLSTONE, PAUL (J) sales manager, L. Pearlstone, 1004 North Broadway, *St. Louis.*

PILLARS, E. R. (A.) general manager, Fostoria Screw Co., *Fostoria, Ohio.*

POTTER, ELBERT L. (J) assistant experimental engineer, Hupp Motor Car Corporation, *Detroit;* (mail) 8600 Epworth Boulevard.

REEVES, CLIFTON (M) industrial engineer, General Motors Building, Detroit; (mail) 341 Madison Avenue, *New York City.*

RIESS, P. R. (A) New England service superintendent, Reo Motor Car Co., Lansing, Mich.; (mail) 73 School Street, *Springfield, Mass.*

ROEHRER, RAY H. (J) service manager, Sayers & Scovill Co., *Cincinnati;* (mail) 2513 Stratford Avenue.

ROSE, RAYMOND HUGH (F M) automotive engineer, Guy Motors, Ltd., Fallings Park, Wolverhampton, England; (mail) Highcliffe, Limefield Road, *Kersal, Manchester, England.*

RUNDQUIST, GUST (J) detailer, Locke & Co., *Rochester, N. Y.;* (mail) 32 Sidney Street.

SCHINDLER, CORNEL (A) draftsman, Sikorsky Mfg. Corporation, *College Point, N. Y.;* (mail) c/o George Sparling, 316 19th Street.

SCHIPPEL, HENRY F. (M) tire design engineer, B. F. Goodrich Co., *Akron, Ohio;* (mail) 816 Work Drive.

SCHUBERT, FRANK R. (M) vice-president in charge of all operations, McGill Metal Co., 915 Lafayette Street, *Valparaiso, Ind.*

SMITH, EARL C. (J) experimental department, American-LaFrance Fire Engine Co., Inc., *Elmira, N. Y.;* (mail) 315½ Lormore Street.

SMITH, RONALD C. (J) machinist, Autocar Co., Ardmore, Pa.; (mail) Southmore Court, *South Ardmore, Pa.*

SPOONER, F. E. (A) editorial representative, McGraw-Hill Co., New York City; (mail) 11 Tucson Road, *Maplewood, N. J.*

STEEVER, ADAM M. (M) chief metallurgist, Great Lakes Forge Co., Chicago; (mail) 355 Elm Street, *Blue Island, Ill.*

STOLTE, RICHARD C. (M) engine designer, engineering department, Olds Motor Works, *Lansing, Mich.*

STUBNITZ, M. (A) sales manager, automotive division, Fort Pitt Bedding Co., Liverpool Street and Preble Avenue, North Side, *Pittsburgh.*

TRUBE, ROBERT L. (A) sales engineer, North East Electric Co., 4473 Cass Avenue, *Detroit.*

ZAP, EDUARD (M) designing engineer, General Motors Corporation, Research Laboratories, *Detroit;* (mail) 650 West Bethune Avenue.

VOL·XX NO·6

THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

JUNE 1927

SUMMER MEETING NUMBER

SOCIETY OF AUTOMOTIVE ENGINEERS INC.
29 WEST 39TH STREET NEW YORK, N. Y.

Issued monthly, $1 per copy, $10 per year; foreign $13 per year; to members, 50 cents per copy, $5 per year.
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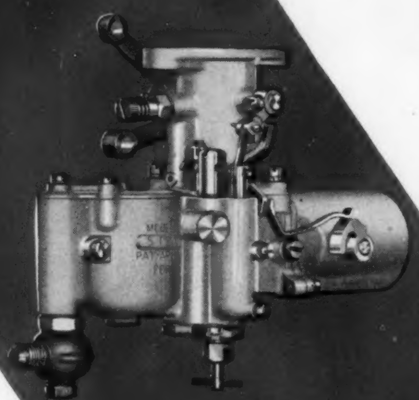
Tillotson

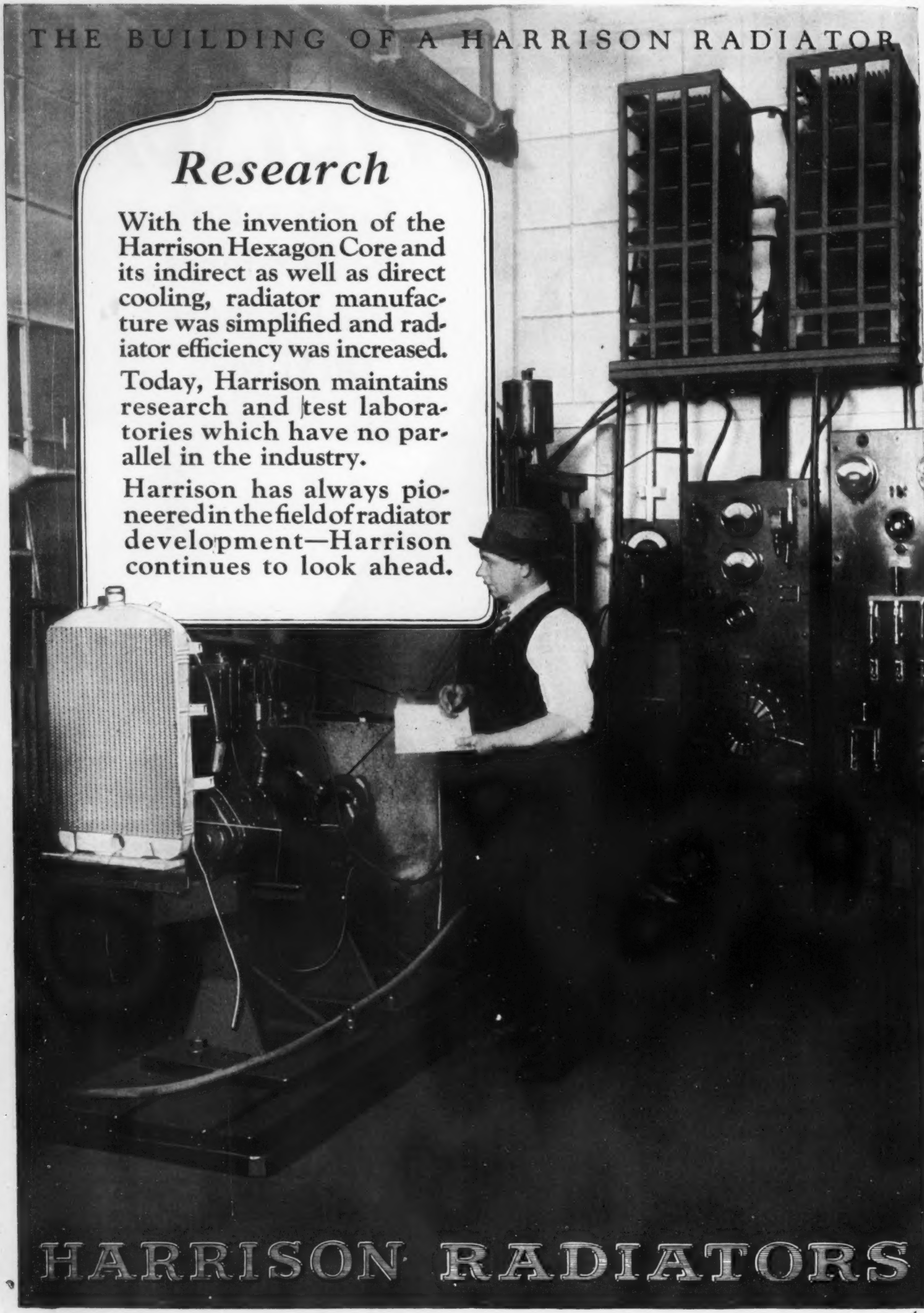
Carburetors
Gas Strainers
Air Cleaners
Oil Filters

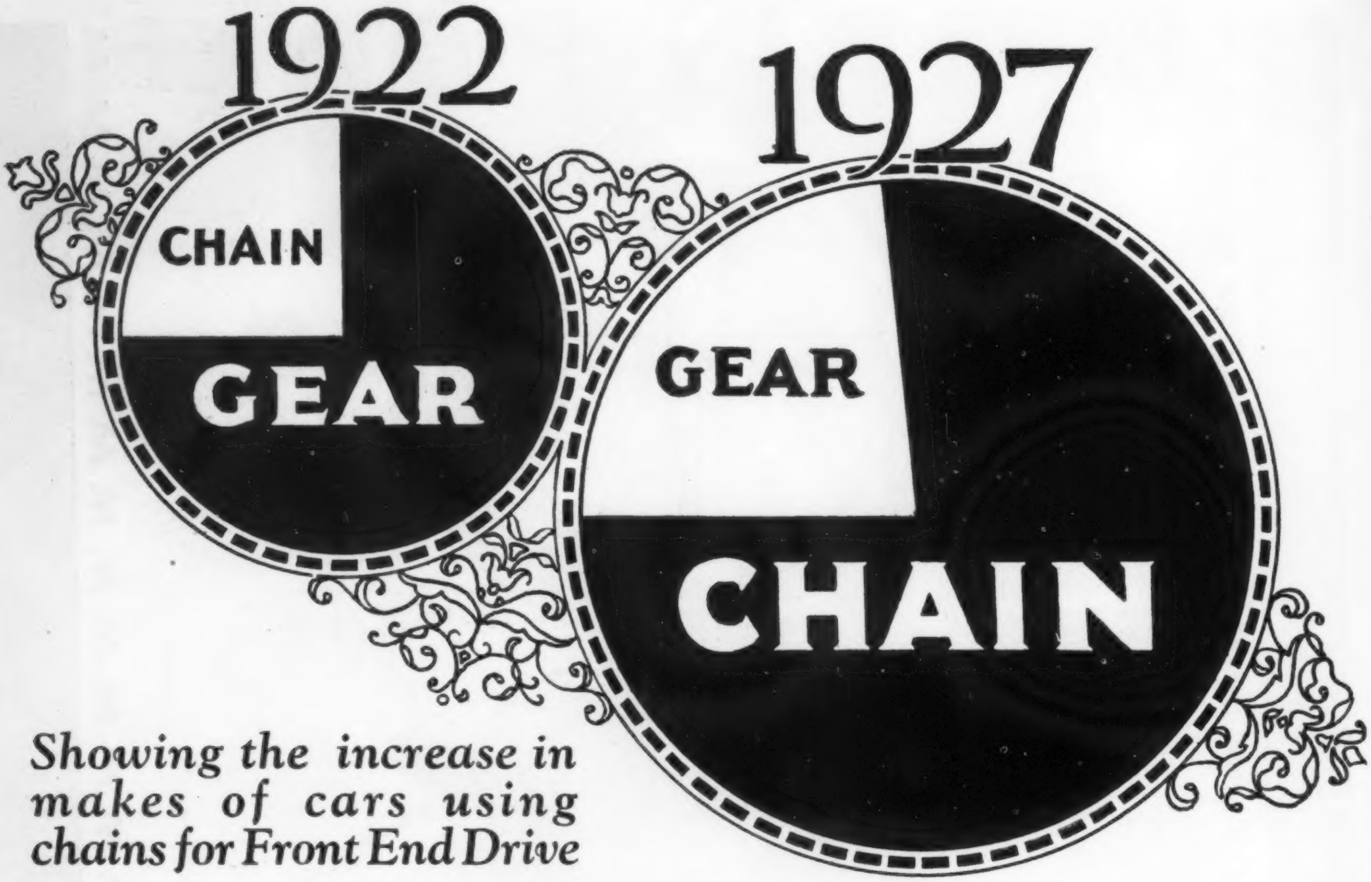


More motorists will tour the highways this summer than ever before. Everyone of those millions want smooth, powerful uninterrupted performance. Thousands *will not* get it and not knowing exactly what the trouble is they will blame the car. All they need is the reliable and better performance insured by Tillotson units. For dependable, uniform operation always use Tillotson.

TILLOTSON MANUFACTURING CO.
Toledo Ohio

"The logical one is Tillotson."


THE BUILDING OF A HARRISON RADIATOR
Research
With the invention of the Harrison Hexagon Core and its indirect as well as direct cooling, radiator manufacture was simplified and radiator efficiency was increased.
Today, Harrison maintains research and test laboratories which have no parallel in the industry.
Harrison has always pioneered in the field of radiator development—Harrison continues to look ahead.
HARRISON RADIATORS



Showing the increase in makes of cars using chains for Front End Drive

Most of Them Are Morse

Including practically all the New Models announced this year, Morse Silent Chains are standard equipment on the following cars and motors:

Adler Standard Six
Cadillac Eight
Chandler Big Six
Chandler Special Six
Chandler Standard Six
Chrysler Six (60)
Chrysler Six (70)
Chrysler Six (80)
Davis Six (92)
Davis Six (93)
Diana Eight
Erskine

Essex Six
Fiat Six—(5-90)
Flint Six (Jr.)
Flint Six (60)
Flint Six (80)
Hudson Six
Hupmobile Six
Hupmobile Eight
Jordan Eight (GL)
Jordan Eight (L)
LaSalle
Lincoln Eight

Moon Six (6-60)
Oakland Six
Oldsmobile Six
* *A manufacturer of high grade Sixes and Eights*
* *—name on request.*
Peerless Six (72)
Peerless Six (80)
Pierce Arrow (80)
Pontiac Six
Reo
Rickenbacker Six
Rickenbacker Eight

Star Four
Star Six
Stearns K Four (B)
Stearns K Six (75)
Stearns Model G-8
Continental Motors
Used in a number of the cars listed.
Engine Models W-5

6-E	7-U	7-Z
8-S	8-U	9-K
9-L	11-U	12-Z
14-L	14-U	20-L

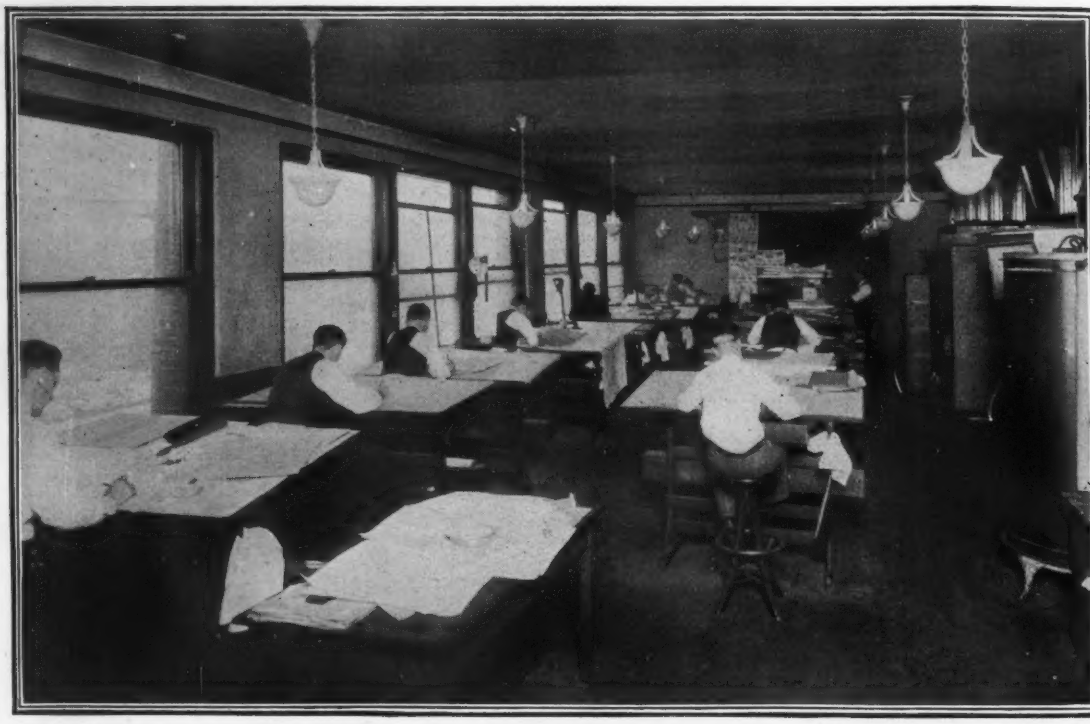
MORSE CHAIN COMPANY

Sales and Engineering Office
DETROIT, MICHIGAN

Main Office and Works
ITHACA, NEW YORK

MORSE

GENUINE SILENT CHAIN



The Stewart engineers know the possibilities of die casting and how to adapt products to the process.

Die casting economy begins with die design

The Stewart Die Casting Corporation maintains a large engineering staff for the sole purpose of designing dies and adapting new products to the Stewart process of die casting. By skillful modification or adjustment these engineers are often able to better the product and at the same time further its economical production as a die casting. Intimate knowledge of the possibilities of the Stewart process and the principles that make die casting an economical method of production enable these men to counsel manufacturers on the advisability of applying die casting to the manufacture of their products.

Dies designed by these engineers are made in a tool room fully equipped to do excellent work at moderate cost. A staff of chemists and metallurgists keep accurate control of metals, alloys and processes. Production is followed closely by rigid inspection before shipment.

Stewart die casting facilities are complete. Stewart methods are progressive. Stewart personnel is thoroughly competent.

Send us your blueprints—advice on die casting problems or possibilities is part of the Stewart policy.

THE STEWART DIE CASTING CORPORATION

(Formerly Stewart Manufacturing Company)

4500 Fullerton Avenue, Chicago, Illinois

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Detroit Milwaukee
Cleveland
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Birmingham Pittsburgh
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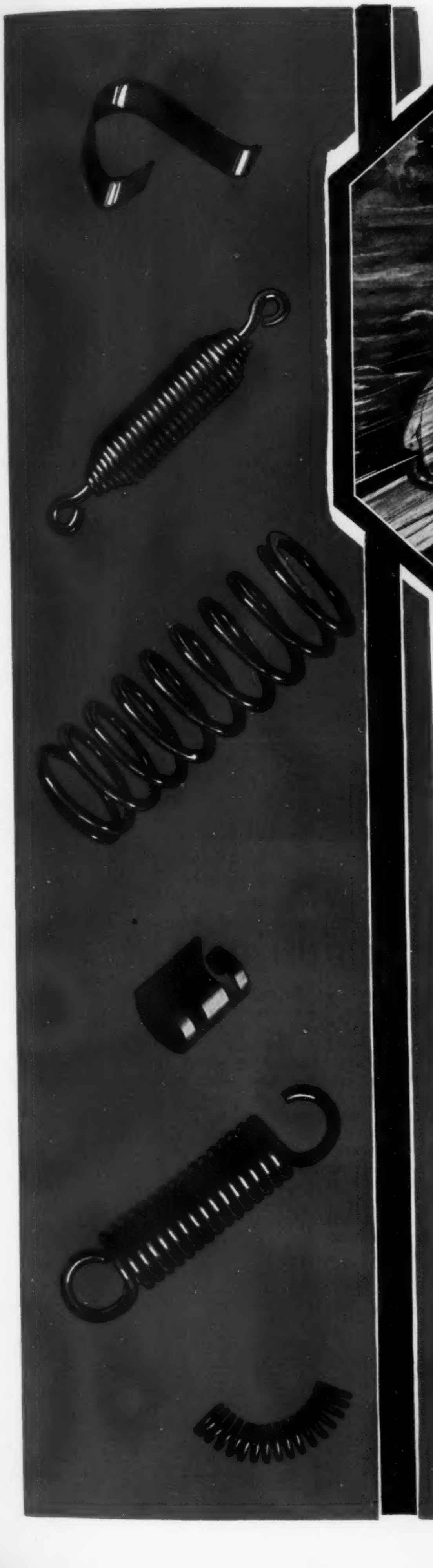
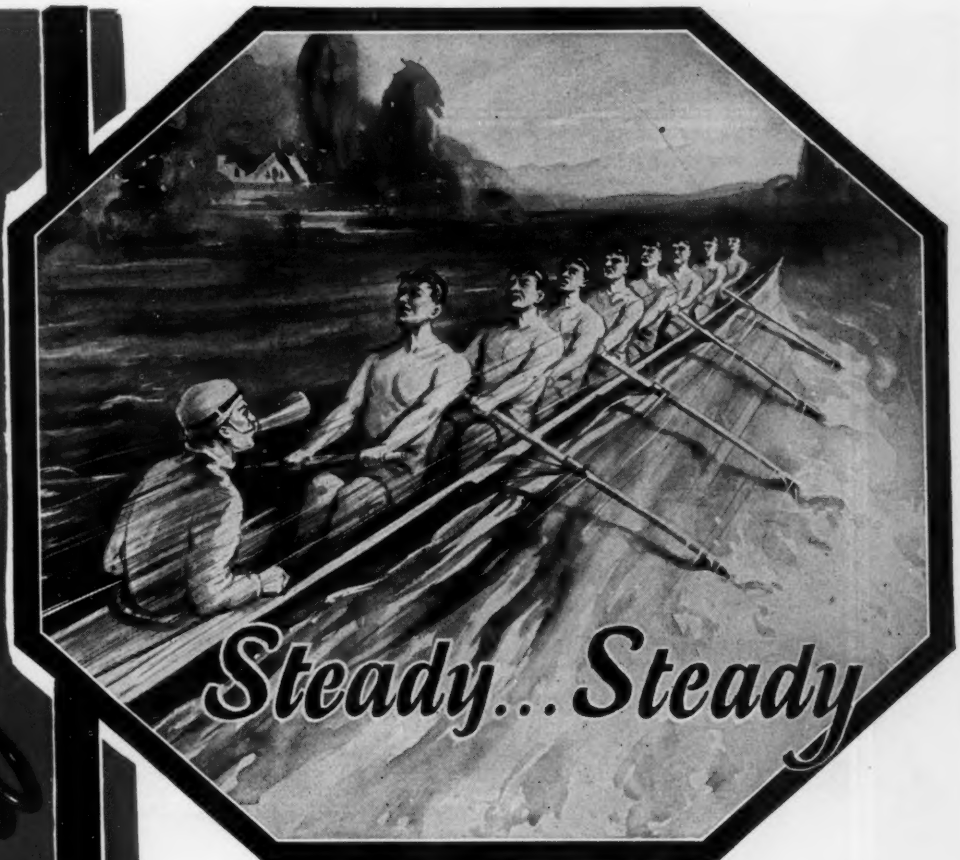
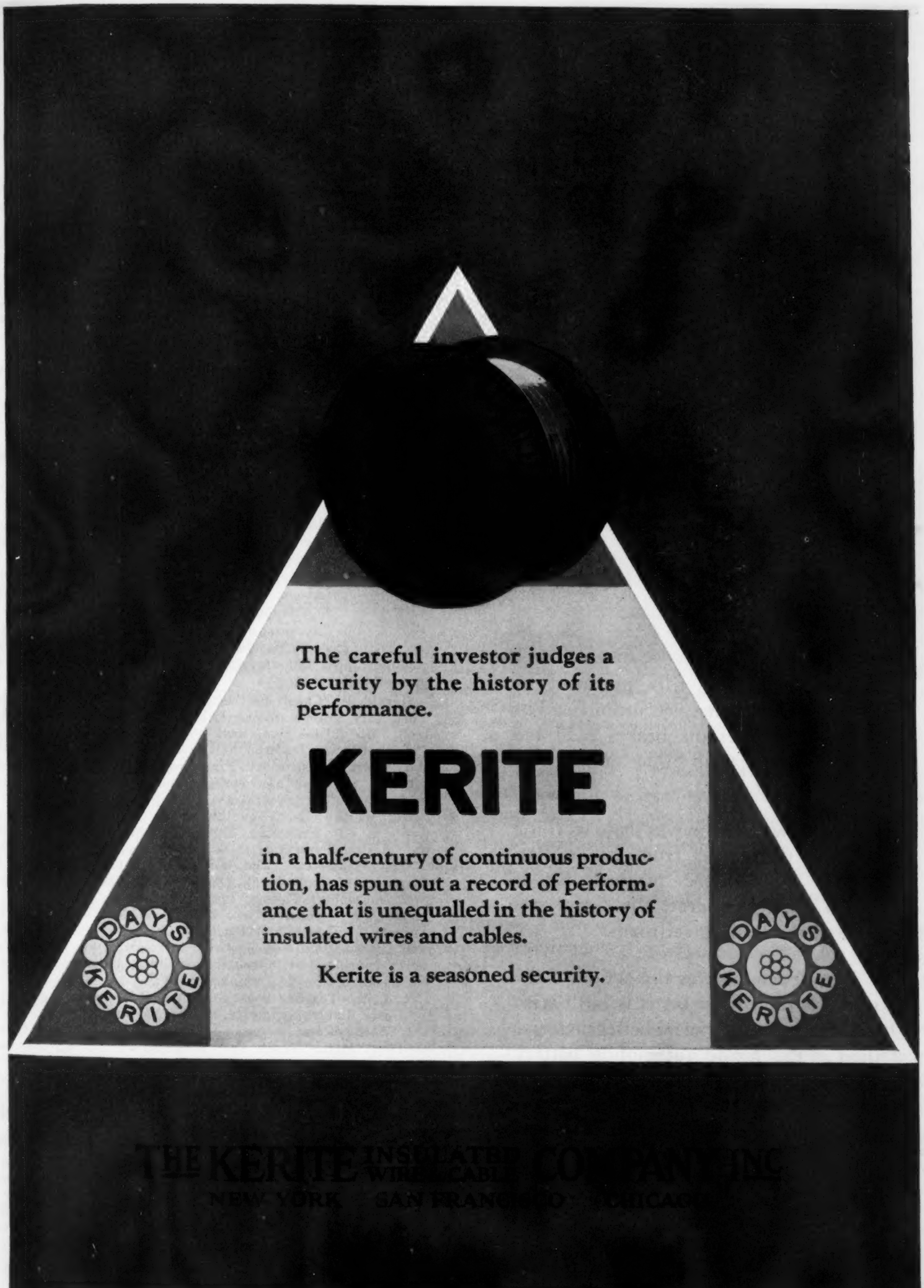



Steady... Steady



The careful investor judges a security by the history of its performance.
KERITE
in a half-century of continuous production, has spun out a record of performance that is unequalled in the history of insulated wires and cables.
Kerite is a seasoned security.
DAYS KERITE
DAYS KERITE
THE KERITE
NEW YORK

Personal Notes of the Members

Items regarding changes in business connections, promotions, etc., are desired from the membership for insertion in these columns. This will enable members to keep their friends informed of their whereabouts and will also assist in keeping the records of the Society up to date.

J. O. Almen, research engineer with the General Motors Corporation Research Laboratories, Detroit, is now head of the dynamics section.

Robert Atkinson has recently become associated with the Timken Roller Bearing Co., Canton, Ohio, and is in charge of the steel sales for the Detroit district. He was formerly affiliated with the Detroit office of the Halcomb Steel Co., Syracuse, N. Y., as metallurgical sales engineer.

Paul Brehm has accepted a position with the Twin Coach Co., Kent, Ohio. Prior to establishing this connection he was general superintendent of equipment and maintenance for the Motor Transit Corporation, Chicago.

A. K. Brumbaugh, who was previously electrical engineer for the Autocar Co., Ardmore, Pa., has become assistant commercial engineer for the White Motor Co., Cleveland.

L. J. Buerkle, formerly electrical engineer for the Dayton Engineering Laboratories Co., Dayton, Ohio, is now affiliated with Automatic Appliances, Inc., also of Dayton.

C. A. Chayne, research engineer for the Lycoming Mfg. Co., Williamsport, Pa., has severed his connection with that company. No announcement has been made concerning his plans for the future.

Harold W. Cheel has resigned as manager of the New York City branch of the Ever Hot Heater Sales Co., Detroit. His future plans have not been made known.

J. R. Clarke, Jr., who until recently was associated with the American LaFrance Fire Engine Co., Inc., New York City, on the assistant works manager's staff, has become salesman for Ingraham & DuBosque, also of that city.

Herbert C. Colburn has opened the Colburn Radio Laboratories at San Francisco. Previously he was affiliated with the sales department of C. S. Norton, Inc., Denver.

John V. Costello, who was formerly captain in the Air Corps at McCook Field, Dayton, Ohio, is now associated with Duesenberg Motors, Inc., Indianapolis.

James J. Crookston, who entered the employment of the Autocar Co., Ardmore, Pa., last August as draftsman, is now experimental engineer with this company. He was formerly connected with the experimental department of the Waukesha Motor Co., Waukesha, Wis.

N. J. den Tex has been appointed chief sales engineer of the Oertz Rudder Syndicate, New York City.

A. W. Deyo has resigned as chief engineer of the Larrabee-Deyo Motor Truck Co., Binghamton, N. Y., although still being retained in a consulting capacity. On May 1 he became affiliated with the Deyo Oil Co., also of Binghamton, as engineer in charge of equipment.

Ralph N. DuBois, associate engineer of the automotive powerplants section of the Bureau of Standards, City of Washington, has resigned, and has joined the engineering staff of the A. C. Spark Plug Co., Flint, Mich.

H. S. Durland, who was until recently research engineer in the Department of Architecture, State of New York, and also as instructor at Pratt Institute, Brooklyn, N. Y. has accepted a position as service engineer for the American Laundry Machinery Co., New York City.

(Continued on p. 22)

PERSONAL NOTES OF THE MEMBERS

Continued

Karl Feilcke has severed his connection with the White Motor Co., Cleveland. No announcement has been made regarding his future plans.

H. L. Ferris, who was previously assistant director of the maintenance and service division of the Eastern district of the General Motors Truck Co., New York City, has become affiliated with the Autocar Sales & Service Co., Philadelphia.

A. H. Frauenthal, formerly chief inspector and metallurgist of the Chandler Motor Car Co., Cleveland, has joined the engineering department of the Studebaker Corporation of America, South Bend, Ind.

Paul H. Geyser, vice-president of the Yellow Truck & Coach Mfg. Co., Chicago, has been appointed head of the cab sales division of the Yellow Cab factory.

W. T. Gridley, previously vice-president and general manager of the Depot Motor Bus Lines, Inc., Chicago, has become associated with the International Coach Lines, also of that city, in a similar capacity.

Nelson R. Haas is vice-president and chief engineer of Automatic Appliances, Inc., Dayton, Ohio. Prior to establishing this connection he was chief engineer of N. R. Haas Engineering, also of that city.

A. H. Harris, previously superintendent for the W. P. Herbert Co., Los Angeles, has become lubrication engineer in the San Francisco branch of the Tide Water Oil Sales Corporation, New York City.

Sid Harris has accepted a position as sales engineer in the spark-plug division of the Moto Meter Co., Long Island City, N. Y. He formerly held a similar position with the B. G. Corporation, New York City.

Charles D. Hastings, who was until recently president and general manager of the Hupp Motor Car Corporation, Detroit, is now chairman of the board of directors.

R. W. Hautzenroeder has resigned as chief engineer of the Allerding Products Co., Mansfield, Ohio, and has become experimental designer for the Superior Gas Engine Co., Springfield, Ohio.

L. H. Hazard has been appointed manager of the O. E. Szekely Co., Holland, Mich.

L. Clayton Hill, previously manager of the automotive sales division of Valentine & Co., New York City, has been made assistant sales manager of the Murray Corporation of America, Detroit.

William M. Holaday, who was formerly engineer of tests for the Westinghouse Air Brake Co., Wilmerding, Pa., is now dynamometer engineer for the Standard Oil Co. of Indiana, Chicago.

Samuel W. Huff has severed his connection with the Lycoming Mfg. Co., Williamsport, Pa. where he was experimental engineer. His plans for the future have not been made known.

Thomas H. Huff has resigned as president and director of Huff-Daland Airplanes, Inc., Bristol, Pa. No announcement has been made regarding his future plans.

R. S. Hurd is now affiliated with the Hurd Bus Line, Inc., Miami, Fla. He was previously president of the Biscayne Terminal Co., also of that city.

Edward R. Klein, who was formerly designer for the Sheldon Axle & Spring Co., Wilkes-Barre, Pa., has accepted a position with the International Motor Co., Allentown, Pa.

H. B. Lewis has formed a partnership to be known as Burns & Lewis, with offices at Los Angeles and will specialize in research work. He was previously experimental engineer on automotive development for the Hughes Tool Co., Houston, Tex.

(*Concluded on p. 24*)

PERSONAL NOTES OF THE MEMBERS

Concluded

Charles F. Loew, who was until recently vice-president of the Loew Mfg. Co., Cleveland, has become associated with the American MonoRail Co., also of Cleveland, in a sales and engineering capacity.

John H. McCormick, formerly secretary, treasurer and general manager of the Lycoming Mfg. Co., Williamsport, Pa., now holds the office of president of the company.

Edward B. McCune has severed his connections with the International Harvester Co., where he held the position of assistant chief engineer in the engineering department at Fort Wayne, Ind. His plans for the future have not been announced.

John McElroy is now affiliated with the Maverick Mills, East Boston, Mass.

F. D. Moore has been transferred from the General Motors Peninsular S. A., Madrid, Spain, where he was engineer in charge of service and parts operation in distribution of products in Spain, to the General Motors Near East, Ltd., Alexandria, Egypt.

J. M. O'Malley, vocational training officer of the United States Veterans Bureau, Los Angeles, has resigned to become superintendent of division 2 of the California Highway Commission, Redding, Cal.

H. A. Oswald, who was previously Western district sales manager with headquarters at Milwaukee for the Standard Steel & Bearings, Inc., Plainville, Conn., has accepted a position as superintendent of the factory at Stratford, Ont., for Brooks Steam Motors, Ltd., Toronto.

A. H. Packer, who was until recently associate editor of *Motor Age*, Chicago, has accepted a position as copy writer for the Buchen Co., also of Chicago.

John F. Palmer is now associated with the Seiberling Rubber Co., Barberton, Ohio. Previously he was consulting engineer with the Bauer Tire & Rubber Co., Harvey, Ill.

E. C. Selman has severed his connection with the Pierce-Arrow Motor Car Co., Buffalo, and has become associated with the Marmon El Paso Co., Inc., El Paso, Tex.

George E. Shipway, previously president of the Salt's Textile Mfg. Co., Bridgeport, Conn., is now manager of the industrial department of W. A. Harriman & Co., Inc., New York City.

Carl W. Spring has been transferred from the engine laboratory of the Shell Co. of California, Martinez, Cal., where he was assistant engineer, to the company's office at San Francisco, where he holds the position of junior engineer in the automotive department.

G. B. Stone, who was formerly vice-president and general sales manager of the Delco-Remy Corporation, Detroit, has retired from active business.

Hal H. Timian, engineer in charge of the New York City branch of the Stromberg Motor Devices Co., Chicago, has severed his connection with that organization and is now engineer for the Wheeler-Schebler Carburetor Co., Indianapolis.

A. V. Verville, who was formerly vice-president in charge of engineering for the Buhl-Verville Aircraft Co., Detroit, has returned from Europe after an inspection of aviation activities there.

J. F. Werner, chief body engineer of the Kissel Motor Car Co., Hartford, Wis., sailed on June 2 for Europe. He plans to visit a number of automobile plants in Switzerland and Germany, paying particular attention to some of the different methods of body construction as compared with those in vogue in this Country, and will return about Sept. 15.

D. McCall White has been appointed chief engineer and assistant to the president of Brooks Steam Motors, Ltd., Toronto, Ont. Prior to establishing this connection he was manager of the Bendix Brake Co., South Bend, Ind.

Notes and Reviews

This column, which is prepared by the Research Department, gives brief items regarding technical books and articles on automotive subjects. As a general rule, no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

Dynamic Forces in Aircraft Engines. By B. C. Carter. Published in *The Journal of the Royal Aeronautical Society*, April, 1927, p. 278.

Mechanical problems, as well as those of fuel injection and combustion, must be solved in the evolution of heavy-oil engines for aircraft. From the first-named class the author chooses for his subject torsional vibration, which, he says, may be obviated in many if not in all cases.

Both experimental results and mathematical analyses are used to demonstrate that in single-throw radial engines resonance effects occur in conformity with a given set theory, that in the design stage calculations can be made which will obviate or minimize harmful torsional resonance effects and that torsional resonance can be converted from an enemy to a friend by suitable design.

Methods of calculating the main synchronous speed are set forth, as well as the effects of driving a supercharger and various types of damper from the tail end of the crankshaft, and of big-end clearance. Torsional vibration in multiple-crank engines is briefly discussed.

Antiaircraft Progress, 1926. By G. M. Barnes. Published in *Army Ordnance*, March-April, 1927, p. 339.

At 4000 yd. slant range, the average range of the Fort Tilden tests of antiaircraft guns made in the summer of 1925, about 3 hits per battery per minute were obtained. Experiments with different methods and different types of equipment finally led to the raising of this figure, over a similar range, to 10 hits per battery per minute at the tests at the Aberdeen Proving Ground in 1926. Beyond 5000 yd. at Fort Tilden the hits per battery per minute approached 0, while at Aberdeen approximately 8 hits per battery per minute were made. In the contrast between the results of the two sets of trials is briefly told the history of 12 months' of progress in antiaircraft technique, which this article covers in some detail.

Are Aviation Records Worth While? By W. L. Le Page. Published in *Aviation*, April 18, 1927, p. 767.

The status of the international air record situation at the present time is summarized in the following words: France leading and pushing ahead, the United States second and on the downward path, and Italy third and climbing up the scale. This estimate is arrived at as a result of plotting the distribution during the last 6 years of the 168 world records recognized by the Federation Internationale Aeronautique and that of 9 records selected as basic and significant.

This withdrawal of the United States from its position is deplored as records are considered by the author as important both in the establishing of world prestige and in the furthering of technical development.

Approximations for Column Effect in Airplane Wing Spars. By Edward P. Warner and Mac Short. National Advisory Committee for Aeronautics Report No. 251. Published by National Advisory Committee for Aeronautics, City of Washington. 20 pp.; 15 illustrations.

The significance attaching to "column effect" in airplane wing spars has been increasingly realized with the passage of time, but exact computations of the corrections to bending-moment curves resulting from the existence of end loads are frequently omitted because of the additional labor involved in an analysis by rigorously correct methods. The present report represents an attempt to provide for approximate column effect corrections that can be graphically or

(*Continued on p. 28*)

Has Lubrication Progress Left Your Car Behind?

BOWEN SYSTEM OF CHASSIS LUBRICATION

Now Standard Equipment on

CLEVELAND
MARMON
CHANDLER
McFARLAN
ELCAR
CUNNINGHAM (Optional)
ASTER (England)
ADLER
N. A. G.
PRESTO
HANSA-LLOYD (Germany) MOTOR CARS
MAJESTIC TAXICABS
CLETRAC TRACTORS
HENNEY FUNERAL COACHES
WILCOX MOTOR COACHES

Its adoption by other manufacturers of motor cars and trucks will be announced in the near future.

Obsolete chassis lubricating equipment annually takes a staggering toll from many otherwise up-to-date cars.

NOT only is obsolete lubricating equipment a handicap in the face of today's competitive conditions but it is likely to prove a liability to your car's reputation. Too often premature wear with resultant repair bills, directly traceable to neglected or ineffective lubrication, is charged by the owner against defects in the car itself.

With the fact established that fully 80% of the expense connected with the operation of a modern motor car is due to neglected, inadequate or ineffective lubrication, isn't it time that chassis lubrication receives the same attention accorded to the improvement of other parts of the car?

The Bowen System meets this demand. It makes the task of lubricating the chassis so simple and convenient that there is no danger of it being neglected, and does the job thoroughly and effectively.

BOWEN PRODUCTS CORPORATION
Auburn, New York

BOWEN SYSTEM OF CHASSIS LUBRICATION

Before long a car without this advanced method of keeping itself in condition will be considered out of date

NOTES AND REVIEWS

Continued

otherwise expressed so as to be applied with the minimum of labor. Curves are plotted giving approximate values of the correction factors for single and two-bay trusses of varying proportions and with various relationships between axial and lateral loads. It is further shown from an analysis of those curves that rough but useful approximations can be obtained from Perry's formula for corrected bending-moment, with the assumed distance between points of inflection arbitrarily modified in accordance with rules given in the report.

The discussion of general rules of variation of bending stress with axial load is accompanied by a study of the best distribution of the points of support along a spar for various conditions of loading.

The Direct Measurement of Engine Power on an Airplane in Flight with a Hub-Type Dynamometer. By W. D. Gove and M. W. Green. National Advisory Committee for Aeronautics Report No. 252. Published by National Advisory Committee for Aeronautics, City of Washington. 11 pp.; 11 illustrations.

This report describes tests to obtain direct measurements of engine power in flight. Tests were made with a Bendemann hub dynamometer installed on a modified DH-4 airplane Liberty-12 engine to determine the suitability of this apparatus.

This dynamometer unit, which was designed specially for use with a Liberty-12 engine, is a special propeller hub in which is incorporated a system of pistons and cylinders interposed between the propeller and the engine crankshaft. The torque and thrust forces are balanced by fluid pressures which are recorded by instruments in the cockpit.

These tests are said to have shown the suitability of this type of hub dynamometer for measurement of power in flight and for the determination of the torque and power coefficients of the propeller.

Flow and Drag Formulas for Simple Quadrics. By A. F. Zahm. National Advisory Committee for Aeronautics Report No. 253. Published by National Advisory Committee for Aeronautics, City of Washington. 22 pp.; 23 illustrations.

In this text are given the pressure distribution and resistance found by theory and experiment for simple quadrics fixed in an infinite uniform stream of practically incompressible fluid. The experimental values pertain to air and some liquids, especially water; the theoretical refer sometimes to perfect, again to viscid, fluids. For the cases treated the concordance of theory and measurement is so close as to make a resume of results desirable. Incidentally formulas for the velocity at all points of the flow field are given, some being new forms for ready use derived in a previous paper and given in tables.

The present text is a slightly revised and extended form of Report No. 312, prepared by the writer for the Bureau of Aeronautics in June, 1926.

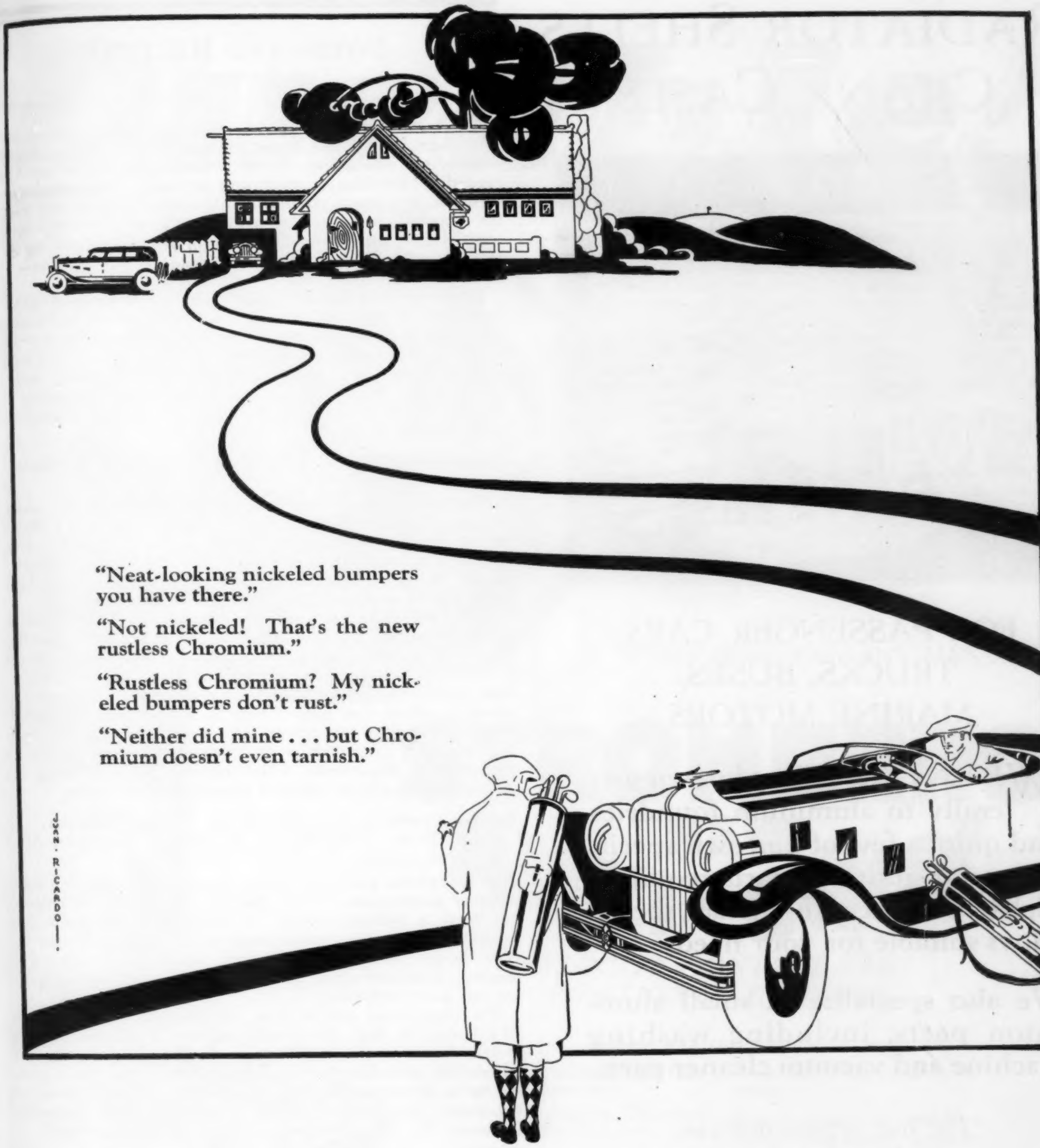
Handbook of Instructions for Type A-1 Airdrome Landing-Field Floodlight. By W. T. Harding. Air Corps Information Circular No. 583. Published by the Chief of Air Corps, City of Washington.

The Type A-1 airdrome landing-field floodlight is used as a ground aid for making emergency landings at night. Its use is contemplated for assistance of those airplanes not equipped with landing lights, or whose lights have failed. Its function is to illuminate an area of the landing field sufficient for making a safe and easy landing under service conditions.

Its construction, installation, maintenance, and operation are described in this circular.

Research Gradually Overcoming Lacquer Color Weaknesses. By A. F. Denham. Published in *Automotive Industries*, April 9, 1927, p. 544.

(*Continued on p. 30*)


"Neat-looking nickeled bumpers you have there."
"Not nickeled! That's the new rustless Chromium."
"Rustless Chromium? My nickeled bumpers don't rust."
"Neither did mine . . . but Chromium doesn't even tarnish."

NOTES AND REVIEWS

Continued

The need for fundamental and specialized research in color technique in the lacquer field is said to be due to two causes: the characteristics of the base color pigments, with regard to durability, luster and covering, that can be determined and are tabulated in this article, persist only when the pigments are used separately and not in combination with others; and knowledge regarding combinations of pigments gained from the study of paints is not applicable to lacquers.

Four criteria must be applied to each new shade of pyroxylin lacquer: resistance to actinic rays, luster, uniformity of shade, and stability of lacquer in solution after application. Comments are made on the success with which a number of shades meet these measurements of quality and a machine for accelerated testing is described. Research on the vehicle part of the lacquer as well as the pigment is recommended.

Murray Body Plant at Indianapolis. Published in *Autobody*, April, 1927, p. 119.

The body plant of which the layout, equipment and operation are here described, is a five-story building about 80x100 ft. It is chiefly devoted to assembly work although some minor woodworking and metal operations are conducted there. It was taken over by the present interests in June, 1926, and is equipped to produce 100 bodies daily.

Parts are raised to the fifth floor of the building where assembly begins. The fourth floor is devoted to painting, the third to trimming, and the second, from which delivery is made, to polishing, inspecting and other final operations. One piece of equipment especially commented on is the steel truck to which the body frame is bolted and to which it remains attached throughout all operations until the body is completed. Another is the special conveyor system in the painting department which carries the body along the ceiling during drying, thereby conserving floor space.

Balance Conditions in a 10-Cylinder 90-Deg. V-Engine. By P. M. Heldt. Published in *Automotive Industries*, April 23, 1927, p. 612.

In a previous paper the author pointed out that in a four-cylinder sleeve-valve engine the sleeves are not in balance, but form a rocking couple. A suggestion was made that possibly this rocking couple could be eliminated by the use of a larger number of cylinders, for instance, 10. This analysis is offered as an illustration of the methods of working out such problems.

The conclusions drawn from the analysis are that in a 10-cylinder 90 deg. sleeve-valve engine, only the primary inertia forces on the crank train parts can be readily balanced; the secondary inertia forces on the crank train parts set up a horizontal rocking-couple; the primary forces on the valve sleeves, a rotating couple; and the secondary forces on the valve sleeves, a horizontal rocking-couple.

Heat Transmission and the Motor-Car Radiator. By William Ernest Dalby. Published in *Engineering*, March 25, 1927, p. 374.

This article is a progress report covering many hundred experiments already made in the course of an extensive investigation of heat transmission across a windswept cooling-surface, with particular application to the motor-car radiator and the locomotive air-cooled radiator.

The first problem solved was to relate the performance of a radiator tested naked in a wind-tunnel with that in a car driven along the road. A surprising difference was observed, in the road tests, between the mean speed of the air through the radiator and the car speed. After some trials, the conclusion was drawn that the conditions for heat dissipation in the tunnel and on the road were substantially the same when the impinging air speed in the

(*Continued on p. 32*)

NOTES AND REVIEWS

Continued

tunnel was made the same as the mean air speed through the radiator.

Heat dissipation tests were made on eight different types of radiator block. One of the findings noted is that a freer flow of air under the hood than is usual practice probably would improve radiator performance to a considerable extent.

Air Cooling. By J. F. Alcock. Published in *The Automobile Engineer*, April, 1927, p. 130.

The author's method for estimating the cooling power of an air-stream over an air-cooled cylinder is intended to supplement the two more commonly used methods, that in which a dummy cylinder is used and the measurement of temperatures in actual air-cooled engines.

Briefly, the procedure consists of exploring the air-stream around the object by a small metal test piece, which is heated and allowed to cool in the air-stream at the point where a reading is required. Knowing the surface area, and the heat capacity of the test piece, the cooling coefficient can be calculated from the observed rate of cooling and this coefficient is taken as applicable, relatively, if not absolutely, to the surface of the cylinder or any other surface adjacent to the test piece.

The construction of the test piece, its calibration and the assumptions involved in its use are taken up. Measurements of the cooling power of air-streams made with the instrument are described and these show, says the author, that the assumptions, under ordinary conditions, do not lead to any serious error.

Linkage-Current Diagram for Representing Magneto Operation. By F. B. Silsbee and D. W. Randolph. Bureau of Standards Scientific Papers No. 543. Published by Bureau of Standards, City of Washington. 52 pp.; 22 illustrations.

This paper puts forward a diagram on which the electromagnetic cycle of operations, which leads to the production of a spark by a magneto or induction coil, can be represented in detail. Areas on the diagram correspond to the energy changes involved. It therefore is analogous to the pressure-volume or the temperature-entropy diagram so widely used in thermodynamic studies.

Methods are given for plotting the diagram from data of various kinds, and sample diagrams are shown. In the appendix is given a detailed mathematical discussion of the oscillations which can occur when a circuit containing inductance, capacitance and resistance is coupled to another containing inductance and resistance only. This combination is similar to the system existing when eddy currents in the core or when the currents flowing in the spark or in the carbon deposit on a fouled spark-plug react on the current in the magneto winding.

Generator Announced for Lighting Vehicles without Battery. Published in *Automotive Industries*, April 9, 1927, p. 542.

The problem in designing a generator to be used without a battery is to provide some type of voltage control, since the three-brush system of output-control is impractical. A feature of the control system of the generator described is that when the lighting circuit is open the shunt-field circuit also is open and the generator is dead. This reduces the wear on the regulator contacts. At 275 to 300 r.p.m. the voltage is sufficient to operate the position lights, while at 500 r.p.m. it approaches close to its maximum value.

Diesel Engines. By Arthur H. Goldingham. Published by E. & F. Spon, Ltd., London. 255 pp.; 185 illustrations.

In this, the third edition of his book on Diesel engines, the author has revised and brought uptodate those chapters dealing with the design of the various makes of this type of engine on the market. These descriptive sections constitute one of the main features of interest, since they assemble in one place details concerning a wide field of

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NOTES AND REVIEWS

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powerplants from those of 10,000 hp. for use in 20,000-ton motorships to 20-hp. engines of the stationary type. The descriptions are supplemented by many informative sectional photographic illustrations and in some cases by performance data. Two chapters are devoted to marine engines, one to the stationary type and one to general constructional details of Diesel engines.

First principles and theory of Diesel engines are expounded, the advantages and disadvantages of the various types are discussed and the questions of testing, installation, operation, and correction are taken up.

Experiments on Oil Jets and Their Ignition. By A. L. Bird. Published in the *Proceedings of the Institution of Mechanical Engineers*, No. 5, 1926, p. 955.

Knowledge of the behavior of oil jets as used in oil-engines and the conditions under which they ignite spontaneously is increasing, but numerous gaps still remain to be filled. The author assists in supplying the lacking information by this report of his experiments, in which the results are conveyed not only by descriptions and tabulations but also by pictures of what actually happens during injection and combustion.

Using various sizes of jet, the author made a comparison of the behavior of the jets in the open air and at various densities and temperatures in the vessel up to those necessary to obtain rapid spontaneous ignition. A timed injection valve such as could be used in an engine was included in the experimental set-up.

The following general conclusions are said to be indicated by the results obtained in the investigation: (*a*) drops of 0.005 to 0.006 in. tend to form, irrespective of other conditions; (*b*) the lack of penetrative power of very fine jets is due as much to the lower velocity generated for a given injection pressure as to the fineness of the atomization; (*c*) up to the point of ignition, the v^2 law of resistance holds substantially; the non-dimensional coefficient being unity for resistance in absolute units, also vaporization from the drops is inappreciable up to this point; and (*d*) after ignition, the motion may be predicted by applying the $v^{1.5}$ law, although the drops are being reduced in size so that this can be regarded only as an equivalent.

Untersuchung über das Flattern der Lenkrader von Kraftfahrzeugen. By Alfred Kauffmann. Published in *Der Motorwagen*, March 20, p. 161 and March 31, 1927, p. 192.

The aim of the work described in this article, an investigation carried out at the Charlottenburg Technical University, was to determine through a systematic research the conditions and the causes of front-wheel shimmy and the measures that should be adopted to combat it.

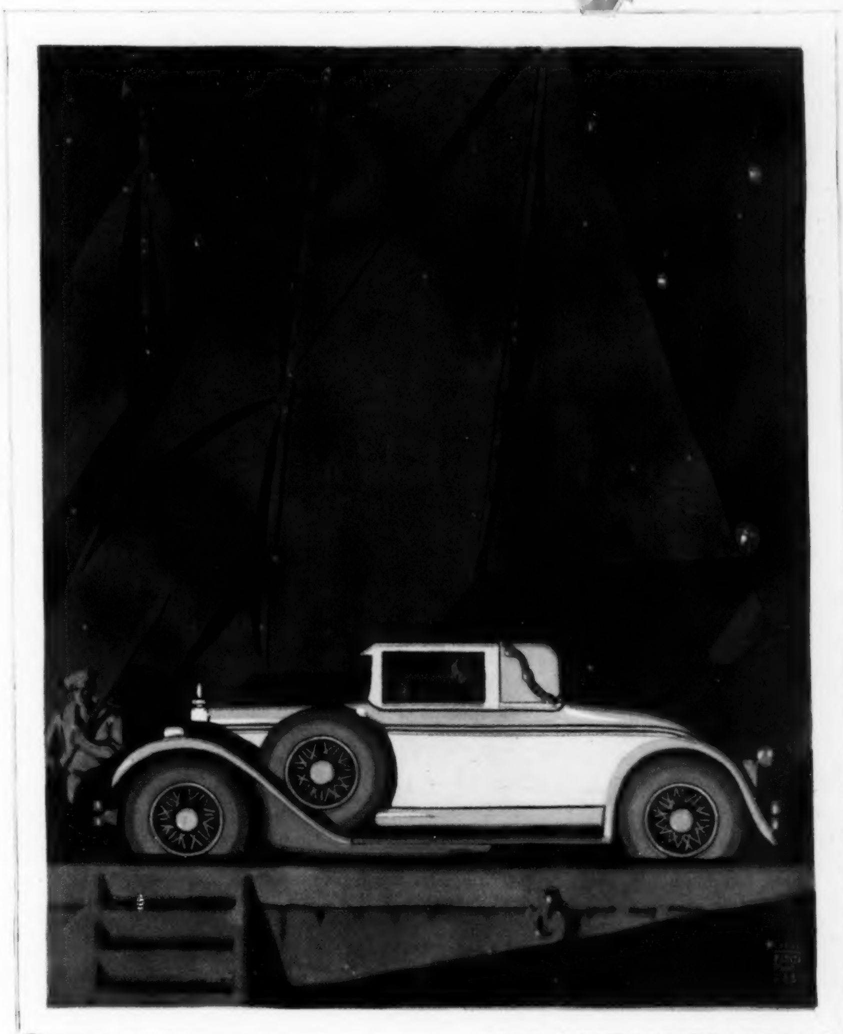
In the investigation a 1922-1924 Horch, a 1925 Buick and a 1926 Mercedes were used. Observations were made both in the laboratory and on the road regarding the effect on shimmy of different types of tire profile, of springs of various stiffness and other factors. As a result of the entire investigation, six factors are selected as of particular influence in the production of shimmy and conclusions are drawn as to the manner in which they affect the phenomenon.

Un Graissage Central par Mèches. By Baudry de Saunier. Published in *Omnia*, April, 1927, p. 904.

This new centralized chassis-lubricating system developed in France is based on an old oiling device, the wick lubricator. In the Alcyl system capillary action alone is responsible for the proper lubrication of spring shackles, brake controls and other minor chassis bearings.

From a central reservoir, located on the dash or in any other convenient place, wicks enclosed in flexible armored tubes radiate to those points about the car where the oil

(*Continued on p. 38*)



Notes and Reviews

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is required. At the extremity of each flexible tube a special type of connector is fitted, which consists of a flat metal-ring. In the interior of this ring is a recess, into which the wick protrudes. This ring is slipped over the regulating screw, which forms the actual lubricator of the bearing, and the oil-hole in the regulating screw is also filled with a wick. The oil arriving from the tube flows into the annular space between the ring and the regulating-screw, and thus reaches the final wick, which conveys it to its destination.

Suspension Systems. By Wilfred Gordon Aston. Published in *The Autocar*, April 1, 1927, p. 521.

Because it gives a thoroughly satisfactory length of springbase, can easily accept braking stresses and enables the points of support of the chassis to be brought practically level with the axles, the half-elliptic type has captured almost exclusively for itself the field of automotive springing, says the author. In this review of modern springing-layouts, he explains the reasons for the disappearance of the quarter and three-quarter elliptics and describes and illustrates the constructional features of 19 different suspension-systems used on well-known makes of cars here and abroad.

Lubricating Oils; Laboratory Tests in Relation to Practical Results. By A. G. Marshall and C. H. Barton. Published in *Engineering*, April 8, 1927, p. 435.

A subject of perennial interest, the relation between laboratory grading of oils and their performance in service, is here discussed by authors who have for several years conducted parallel tests in both fields.

According to Deeley values, the authors point out, fatty oils or compounds of mineral and fatty oils have lower coefficients of friction than mineral oils. However, under normal lubrication conditions, the different types of oil when used in engine tests did not cause any appreciable variation in power output or friction, neither were the wear curves affected by interchanging mineral oil and compounded oil of the same viscosity.

Neither coking nor oxidation tests were found to give any indication of the carbonization results to be expected in engines. Specific gravity and flash-point tests are dismissed with the comment that they give no indication of lubricating quality, and no justification is said to be apparent for the judging of oil by viscosity changes above 70 deg. fahr.

A Study of Petroleum Lubricants. By Charles F. Mabery. Published in *Industrial and Engineering Chemistry*, April, 1927, p. 526.

Twenty commercial lubricants are analyzed as to initial distillation, proportion distilled below 300 deg. cent. (572 deg. fahr.), 30 mm. pressure, and specific gravity and viscosity of the distilled products. A record of the behavior of these oils on a frictional bearing is then given. Oils of the same viscosity were found to have very different lubricating values in respect to durability. The heaviest hydrocarbons of refinery distillation are separated and also analyzed.

Two oils subjected to heavy use, one on a truck and one on an airplane, were examined as to specific gravity, viscosity and behavior on a frictional bearing. The oils were found to have undergone little deterioration through use. The results of tests are said to show that by suitable care in refining, lubricants of equivalent wearing-quality can be prepared from the different classes of crude oil, those with a paraffin, mixed and asphaltic base.

Another branch of the investigation covered in this article was that into the relation between viscosity and temperature. In using viscosity as a criterion of a lubricant, says the author, not only should values at 38 and 98 deg.

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NOTES AND REVIEWS

Continued

cent. (100.4 and 208.4 deg. fahr.) be ascertained, but also at some other temperature between these two points where greater variation in viscosity is apt to be shown.

Cracking Spindletop Crude Yields Gasoline of 45 to 50 Per Cent Benzol Equivalent. By Gustav Egloff and Jacque C. Morrell. Published in *National Petroleum News*, April 13, 1927, p. 87.

A prophecy is made that Spindletop will produce more than 32,000,000 bbl. of crude during 1927 alone. In this investigation of Spindletop oil for its yield of commercial product, heavy and light crudes were cracked, producing respectively 58 and 65 per cent of gasoline in one cycle of operation. The gasolines were found to be equivalent to a blend of from 45 to 50 per cent benzol added to straight-run Pennsylvania gasoline.

Experimental Studies on the Effect of Ethyl Gasoline and Its Combustion Products. By R. R. Sayers, A. C. Fieldner, W. P. Yant, and B. G. H. Thomas. Bureau of Mines Report to General Motors Research Corporation and Ethyl Gasoline Corporation. Published by Bureau of Mines, City of Washington. 447 pp.; 55 illustrations.

This report is a complete statement of the Bureau of Mines investigations on lead tetraethyl, which included three problems.

On Oct. 19, 1923, a cooperative agreement was made between the Bureau of Mines and the General Motors Research Corporation to study the first problem, the toxicity of exhaust-gas from engines using tetraethyl lead and certain halogen compounds as antiknocking materials in the fuel. Two test campaigns were carried out. In the first, extending over a period of 7½ months, animals were exposed to the maximum possible concentration of exhaust-gas from ethyl gasoline that would not cause carbon-monoxide poisoning. In the second, continued for 12 months, five times the commercial proportion of lead tetraethyl was used in the gasoline.

Determining the effects of exposure to the liquid and vapor forms of ethyl gasoline constituted the second and third problems. Their study was undertaken under a supplemental cooperative agreement with the Ethyl Gasoline Corporation, made on Oct. 2, 1924, and was carried on through experiments on animals over a period of about 9 months.

Internal Friction in Solids. By A. L. Kimball, Jr. and D. E. Lovell. Published in *Mechanical Engineering*, May, 1927, p. 440.

In connection with a test devised to determine quantitatively the amount of friction within the metal of a steel shaft, it was found that the internal frictional forces were totally unlike those of a viscous fluid, as assumed by many investigators, where the forces are greater the more rapid is the deformation. Instead of this, the dissipative forces were found to be the same whatever the speed of deformation. The apparatus with which the tests were conducted is described, and the results with 17 different materials are tabulated. Equations relating the variables involved are derived in the analysis of the problem.

Non-Technical Chats on Iron and Steel. By LaVerne W. Spring. Published by Frederick A. Stokes Co., New York City. 465 pp.

This book is not intended as a guide or source of reference; it is designed only to convey to the lay reader a general outline of the nature of iron and steel, the manufacture of these metals and the uses to which their various forms are put, and to bring out impressively the magnitude of the part played by the ferrous metals in both ancient and modern life.

For such a purpose scientific accuracy and completeness are not necessary, and no effort is made to achieve meticulous

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technical exactness. General statements are not elaborated with details nor are exceptions to them noted; they are left to convey in bold, broad strokes the fundamental essential facts. Many other expedients are utilized to hold the interest of the reader; a conversational tone is adopted, picturesque and striking facts are recorded, and descriptions of manufacturing plants and processes are given in the manner of a lecturer conducting a tour. Ample illustrations further the understanding of the book and add to its attractiveness.

The Metallography and Heat Treatment of Iron and Steel. By Albert Sauveur. Published by McGraw-Hill Book Co., Inc., New York City. 535 pp.; 469 illustrations.

Albert Sauveur's comprehensive textbook has a reputation of long standing. First issued in 1912, it was extensively revised and enlarged in 1915. The present third edition incorporates the important advances made in the metallography of iron and steel during the last decade.

Throughout the editions, the author has adhered to his original purpose, to present a well-balanced, specific and scientific treatise. Students seeking self-instruction will find in the book an arrangement especially suited to their needs; teachers, a textbook; manufacturers, much practical information; and the general reader, instruction couched in readily understood language. Controversial matter or speculative theories are not included in this treatise, which is intended to impart instructions based on the sound fundamentals of the science of metallography. The opinions of other authoritative investigators are also presented with the same prominence and emphasis as the author's own.

Comparative Tests on Ball Bearing Steels. By T. L. Robinson. Published in *Transactions of the American Society for Steel Treating,* April, 1927, p. 607.

For many years the steels used in the manufacture of high-grade annular ball-bearings, says the author, have been standard in chemical composition, the chief alloying element being chromium. Recently this steel has been modified by several bearing manufacturers to include other elements such as molybdenum and vanadium. This paper gives the results of tests of a series of alternating-stress tests in which an attempt was made to compare some of the alloy-steels now used.

The alternating-stress tests were supplemented by a static bending-test designed to eliminate as far as possible any alignment factors.

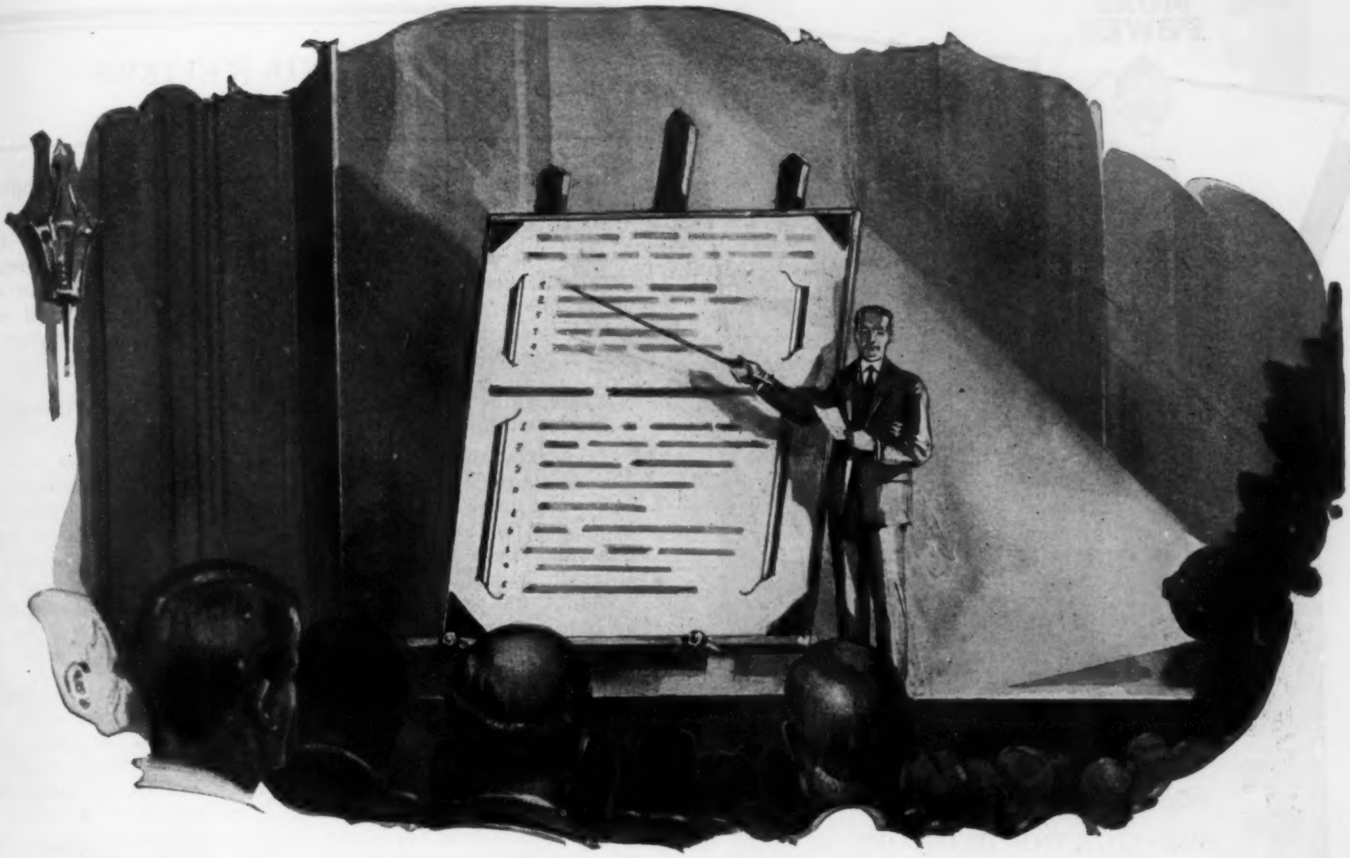
The test results and subsequent microscopic-examination indicated that the size and distribution of the particles of excess cementite were factors in the performance of the steel both under reversed stress or fatigue tests and under the static bending-test. The steels in which these particles of cementite were comparatively small and uniformly distributed showed a markedly greater endurance and strength.

Bearing Metal Bronzes. By Harold J. Roast and Fred Newell. Published in *The Engineering Journal,* April, 1927, p. 213.

The tests here described were intended to give to the engineer descriptive and performance data on various types of bearing metal obtained under the same conditions for each type and hence comparable.

Eleven bearing metals were used in which the tin content varied from 4 to 7 per cent; the lead, from 4 to 15; and the zinc from 1½ to 40. On these alloys the following constants were determined; composition, metal cost, yield-point, tensile-strength, elongation, deformation limit, Brinell hardness, scleroscope hardness, compression at 50,000 and 100,000 lb., weight per cubic foot, and microscopic structure. Where pertinent the tests were made on the original melt, remelt and the annealed metal. Altogether about 300 tests were made involving between 800 and 900 measurements and the figures given are based on the averages, the

(*Continued on p.* 44)



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5. Increased ductility and toughness—
6. Attractive color—
7. Corrosion-resistance.

The adjoining panel gives a brief summary of the present uses of Nickel in the Brass Foundry and the advantages derived therefrom.

Typical uses of Nickel in non-ferrous alloys, together with data regarding results obtained, are covered in the booklet "The Use of Nickel in the Brass Foundry", which will be sent on request.

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NOTES AND REVIEWS

Continued

maximum and minimum of which are said to have differed only slightly.

As a result of the tests the conclusion is drawn that manganese bronze rightly made combines in itself greater strength, greater ductility and greater hardness than any other one of the ordinary bronzes and as such should commend itself to the engineer where such a combination of properties is desired.

Foremanship Training. By Hugo Diemer. Published by McGraw-Hill Book Co., Inc., New York City. 230 pp.

Is it true that in American factories only 5 per cent of the foremanship is being tapped? That chief executives have become absorbed in the increasingly acute questions of marketing and selling; that, for this reason, they have entrusted production control and personnel management to specialized staff systems, thus alienating the foreman and widening the gap between the captains and top sergeants of industry; that in the mechanization of industry the asset of personal loyalty and enthusiasm has been lost?

Vigorously supporting these premises, the author urges that major officials and executives interest themselves directly in the development of foremen, who, in turn, will transmit to the workmen the spirit of organization goodwill. In his book, addressed to the man highest up, he tells what the foreman is, what he should be and how to effect a change. Utilizing his many years of experience as personnel and production superintendent, he presents observations that are keen, fresh and first-hand. Among the interesting extracts from his own experience are an analysis of a foreman's duties based on the statements of foremen in a wide range of industries, and a chart showing the ratings of foremen based on their own estimates and on those of their employers. In the latter part of the book practical directions are given on the successive steps necessary to develop efficient and intelligent foremanship in a plant where these features of training have been neglected.

Motor-Vehicle Taxation and Regulations in Foreign Countries. By C. E. Haynes. Trade Information Bulletin No. 463. Published by Bureau of Foreign and Domestic Commerce, City of Washington. 57 pp.

In Paraguay, only a certain specified overhang of truck bodies measured from the rear axle is permitted; in Switzerland, the total gross weight of a motor-vehicle and its load must not exceed 4 tons; in Ceylon, the legal maximum turning radius is 42 ft. for passenger-cars and 45 ft. for trucks. These are some of the restrictions that must be borne in mind by the automotive manufacturer planning to reach an extensive foreign market. The regulations of foreign countries and their taxes on motor-vehicle sale and operation are summarized in this bulletin, for the preparation of which a special questionnaire was sent to consular officers of the State Department and foreign representatives of the Department of Commerce.

Ventilation of Vehicular Tunnels. By A. C. Fieldner, Yandell Henderson, J. W. Paul, R. R. Sayers, and others. Bureau of Mines Report to New York State Bridge & Tunnel Commission and New Jersey Interstate Bridge & Tunnel Commission. Published By Bureau of Mines, City of Washington. 171 pp.; 69 illustrations.

As an authoritative discussion of the frequently raised questions, what is the carbon-monoxide content of the exhaust gases of motor-vehicles and what is the effect of carbon monoxide on the health of human beings, this report is of much interest. The probability that vehicular tunnels will be increasingly utilized to relieve traffic congestion

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adds to the importance of this pamphlet, a report on the extensive cooperative investigation carried out by the Bureau of Mines, the New York State Bridge & Tunnel Commission and the New Jersey Interstate Bridge & Tunnel Commission.

Four separate problems were studied: (*a*) amount and composition of exhaust-gases from motor-vehicles, (*b*) physiological effect of exhaust-gases from motor vehicles, (*c*) determination of the coefficient of friction for the flow of air through concrete ducts, and (*d*) determination of the relative merits of various methods of transverse ventilation for the vehicular tunnel under the Hudson River. Of these, the first, second and fourth are covered in this report.

The Trend of Highway Design. By A. G. Bruce and R. D. Brown. Published in *Public Roads*, March, 1927, p. 7.

The requirement that hard-surfaced pavements shall meet a surface trueness test, easier horizontal and longer vertical curves, practically universal superelevation and widening of curves, a predominating width of 18 ft., the increase in the height of curbs at the edges of the roadway on bridges, and wider shoulders on rural highways—these are some of the developments that are indicated as having marked the course of highway design during recent years.

This article is a review in some detail of the practices now employed by each of the State highway departments and their evolution during the last several years, as indicating the various shades of opinion on doubtful points and the degree of standardization obtained. The analysis is based on a large number of the plans received from the States by the Bureau of Public Roads for Federal-aid projects during the last 6 years.

Other topics included besides those already mentioned are grades and alignment, compensation of grades, grade crossing elimination, road types, and methods of construction.

What the Boston & Maine Transportation Company Did in 1926. By R. J. Littlefield. Published in *Railway Age*, April 23, 1927, p. 1287.

During 1926 the Boston & Maine Transportation Co. operated a total of 1,010,744 motorcoach miles at a cost of \$0.28955 per motorcoach mile. This expense is shown as divided among 13 different items and a summary is given of the installations during the year of motorcoach lines as substitutes for branch-line rail service, for parts of branch-line rail service and for electric railway service and as a supplement for rail service. For each installation comparative figures are given for the costs of rail and motorcoach service and for the results obtained.

\$57,796.90 for What? By James W. Cottrell. Published in *Operation and Maintenance*, April 15, 1927, p. 7.

In the fleet the maintenance of which is the subject of the present article are 77 trucks, practically all with dump bodies, used for the delivery of sand, pebbles and other building material. In addition to these trucks, 37 passenger-cars, used by salesmen and company officials, several portable gasoline-engines and a large motor-cruiser are maintained. The cost of painting trucks, drivers' wages, tires, and gasoline and oil are not included in the figures given, as these expenses are charged to the sales department.

Maintenance charges for 1926 amounted to \$57,796.90 covering labor, material and shop overhead for 77 trucks. An analysis is made to show how much of this expense was due to labor, material and outside labor and material, and also how much was incurred by a number of different parts in the engine and chassis.


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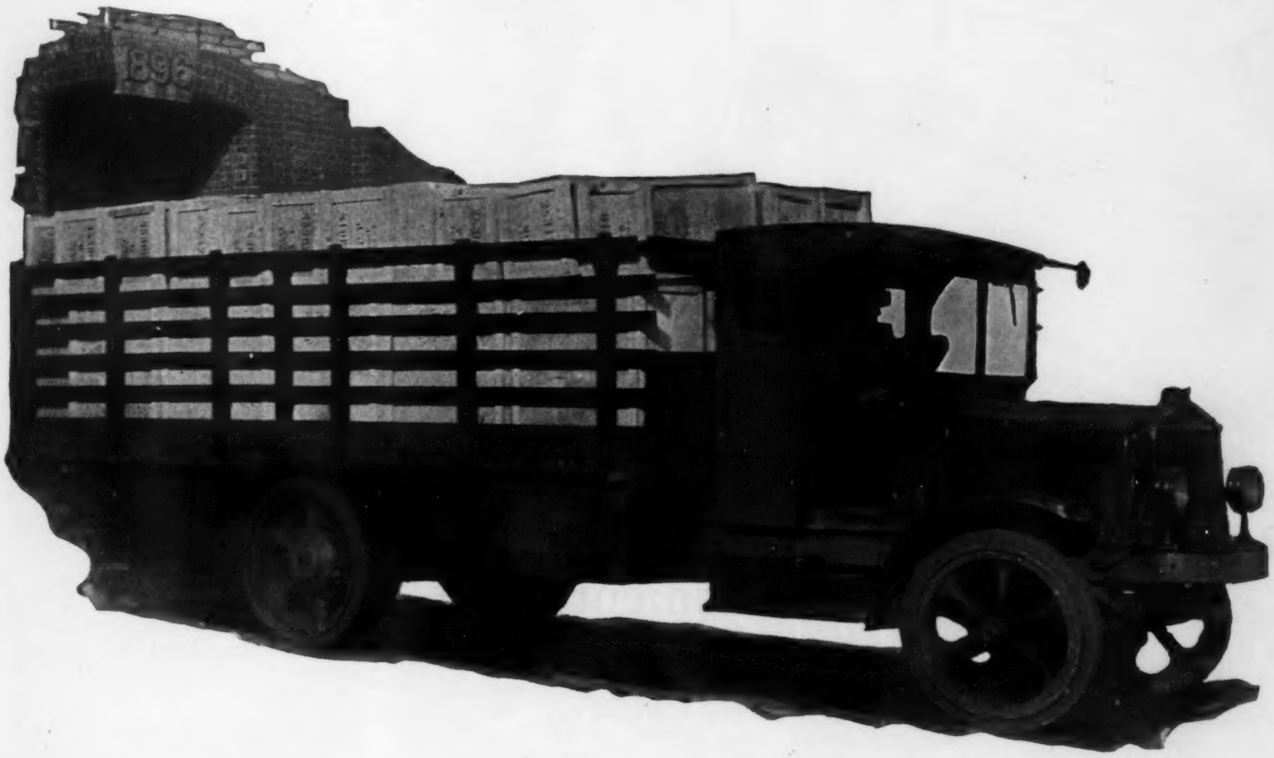

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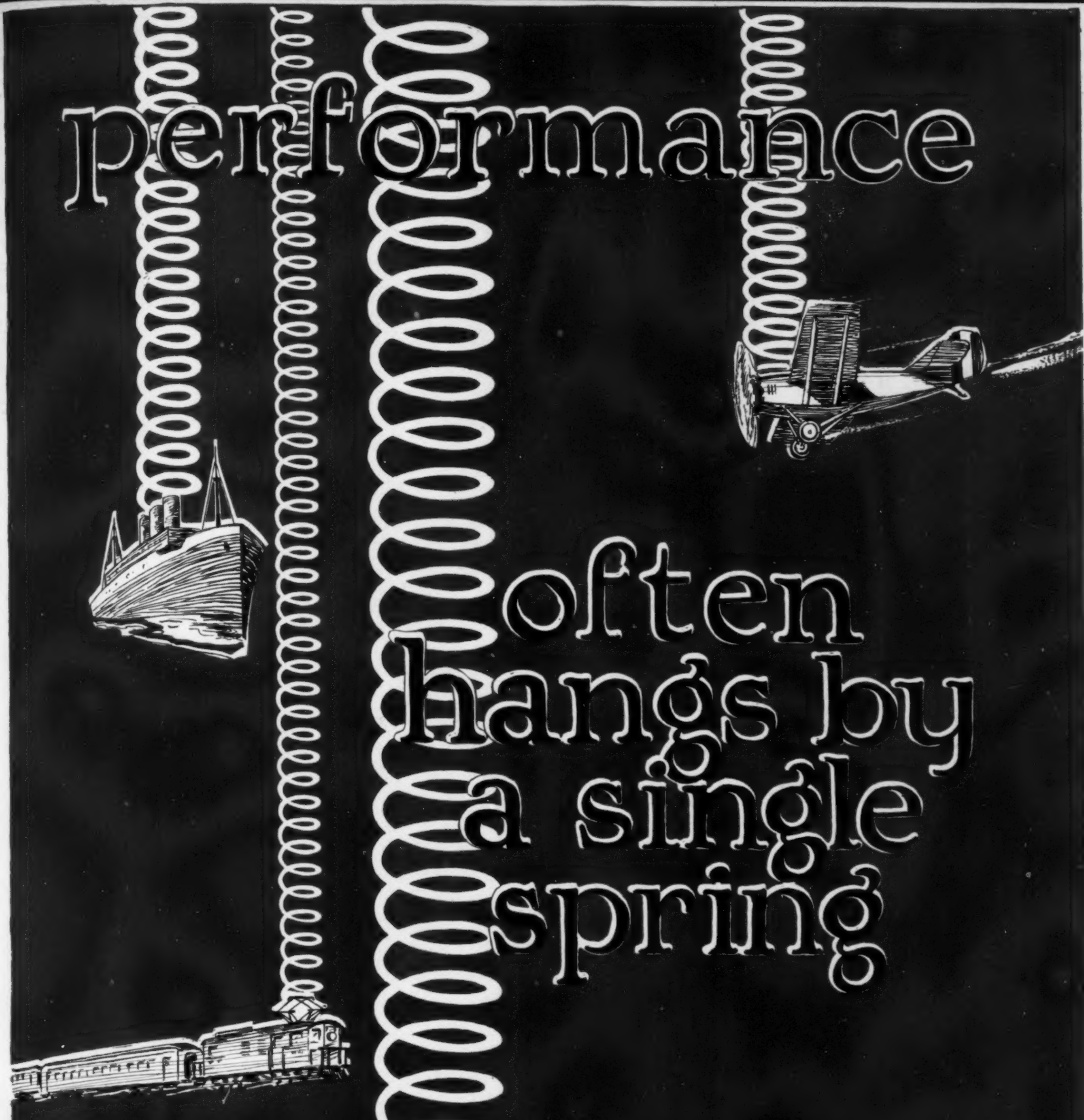
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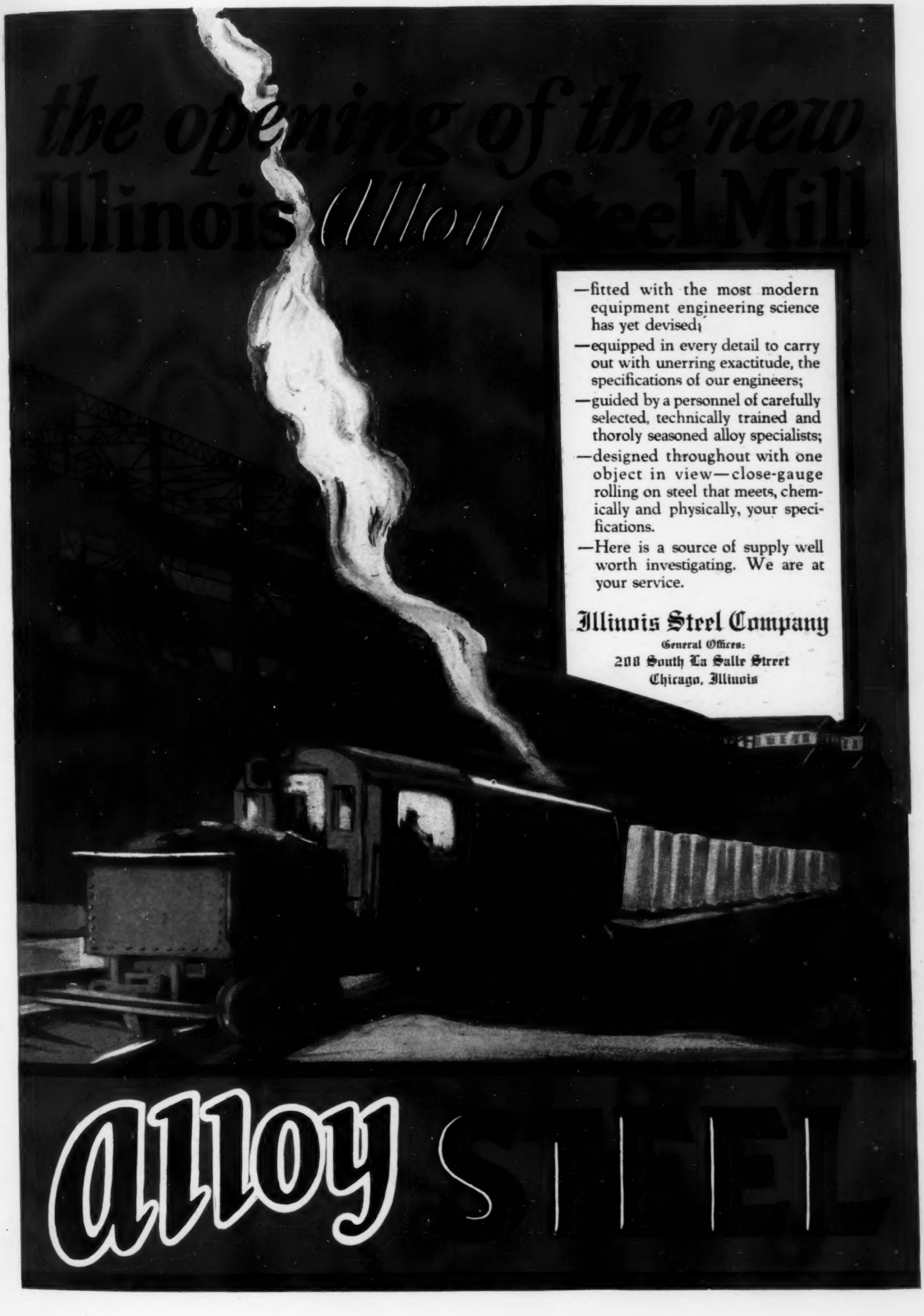
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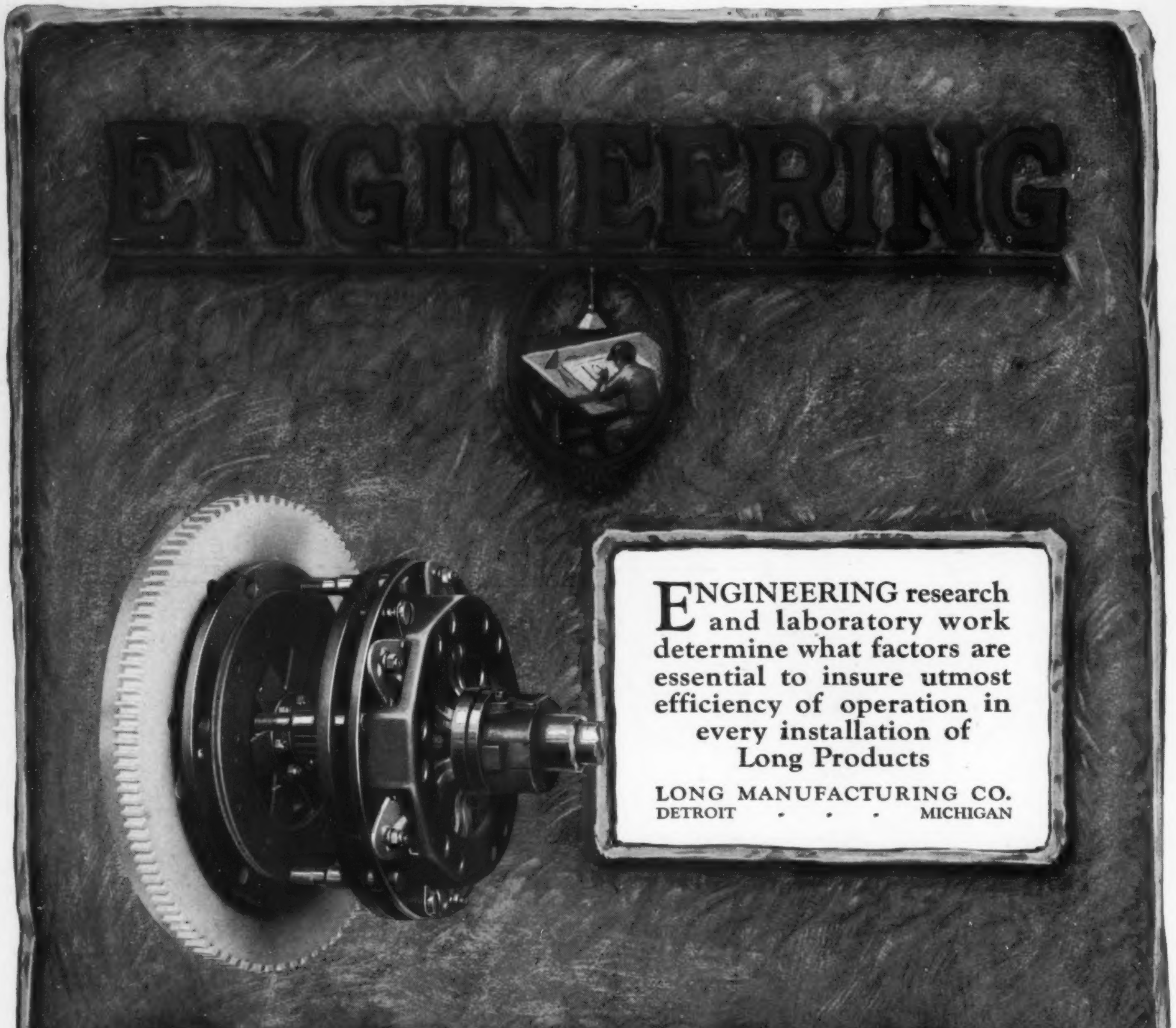
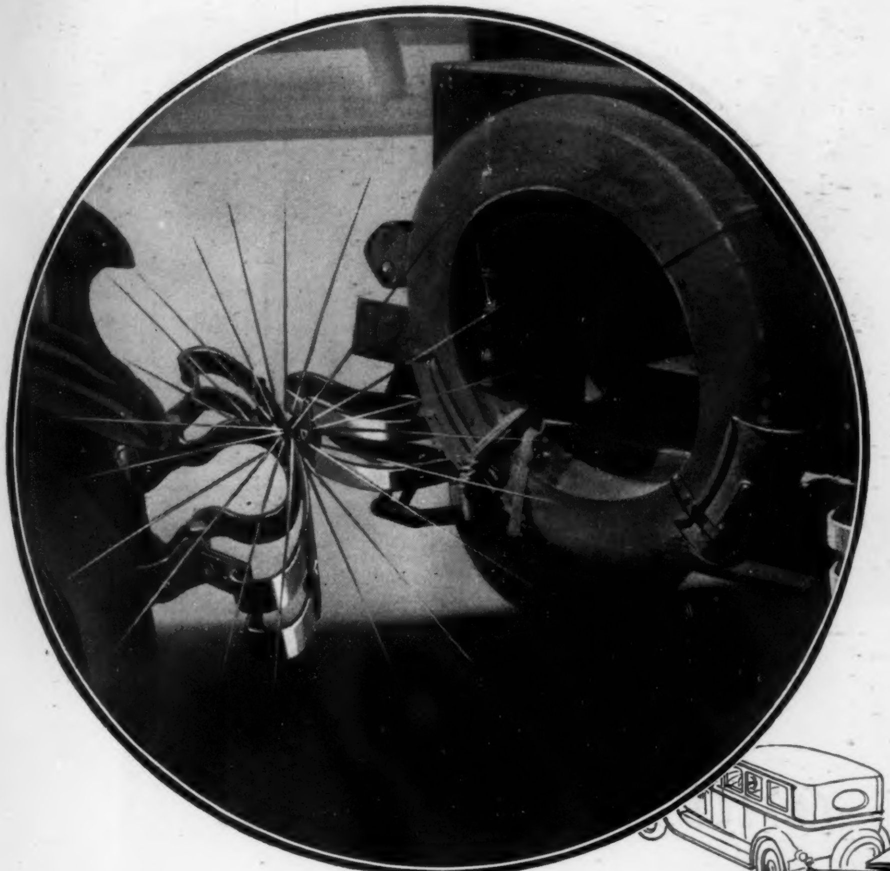

ENGINEERING
ENGINEERING research and laboratory work determine what factors are essential to insure utmost efficiency of operation in every installation of Long Products
LONG MANUFACTURING CO.
DETROIT - - - MICHIGAN
LONG
INTERNATIONAL
LONG PRODUCTS
AUTOMOTIVE CLUTCHES
AND RADIATORS



Weed Bumpers *combat* daily abuse

WEED Bumpers are designed for present-day traffic conditions. Strong and resilient to take hard wallops without distortion, and shaped properly to avoid hooking onto other cars—or tangling in traffic.

Send prints of your frame construction and allow us to submit quotations embodying standard WEED designs.

ACCO
A PRODUCT OF THE AMERICAN CHAIN COMPANY, Inc. in business for your safety

Made by the makers of WEED *Chains and* WEED *Levelizers*

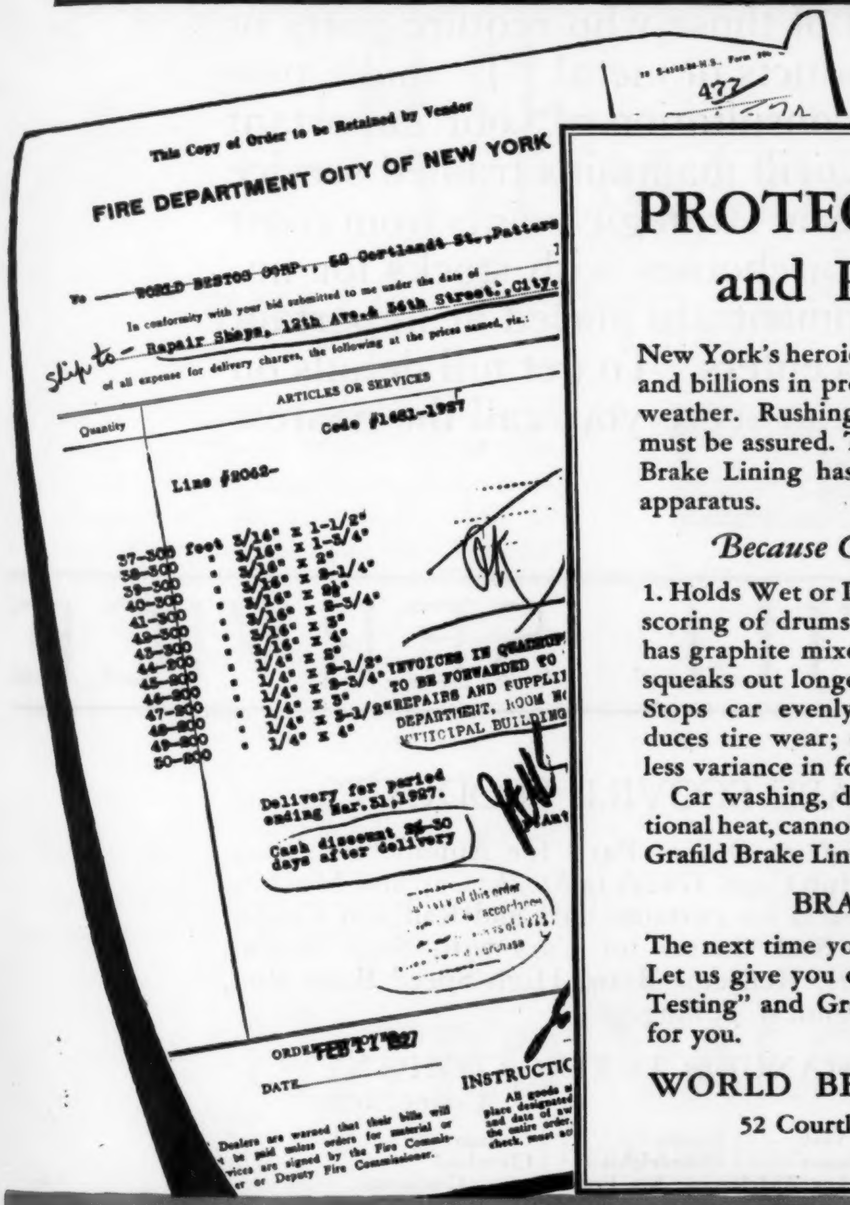
AMERICAN CHAIN COMPANY, *Inc.*
BRIDGEPORT, CONNECTICUT

In Canada: Dominion Chain Company, *Limited,* Niagara Falls, Ontario

World's Largest Manufacturers of Welded and Weldless Chains for All Purposes

WORLD BESTOS GRAFILD BRAKE LINING

"Holds Wet or Dry"



PROTECTING LIVES and PROPERTY

New York's heroic firemen protect millions of lives and billions in property at all hours, whatever the weather. Rushing through crowded streets, safety must be assured. To insure safe, sure stops, Grafild Brake Lining has been specified for department apparatus.

Because Grafild Brake Lining—

1. Holds Wet or Dry; 2. Is graphite filled—prevents scoring of drums; 3. Is the only brake lining that has graphite mixed with crude asbestos; 4. Keeps squeaks out longer, generally eliminating them; 5. Stops car evenly—prevents locking brakes—reduces tire wear; 6 Assures greater safety through less variance in foot pressure.

Car washing, driving rain, slush or puddles, frictional heat, cannot affect the smooth, positive grip of Grafild Brake Lining. Remember, it *holds wet or dry.*

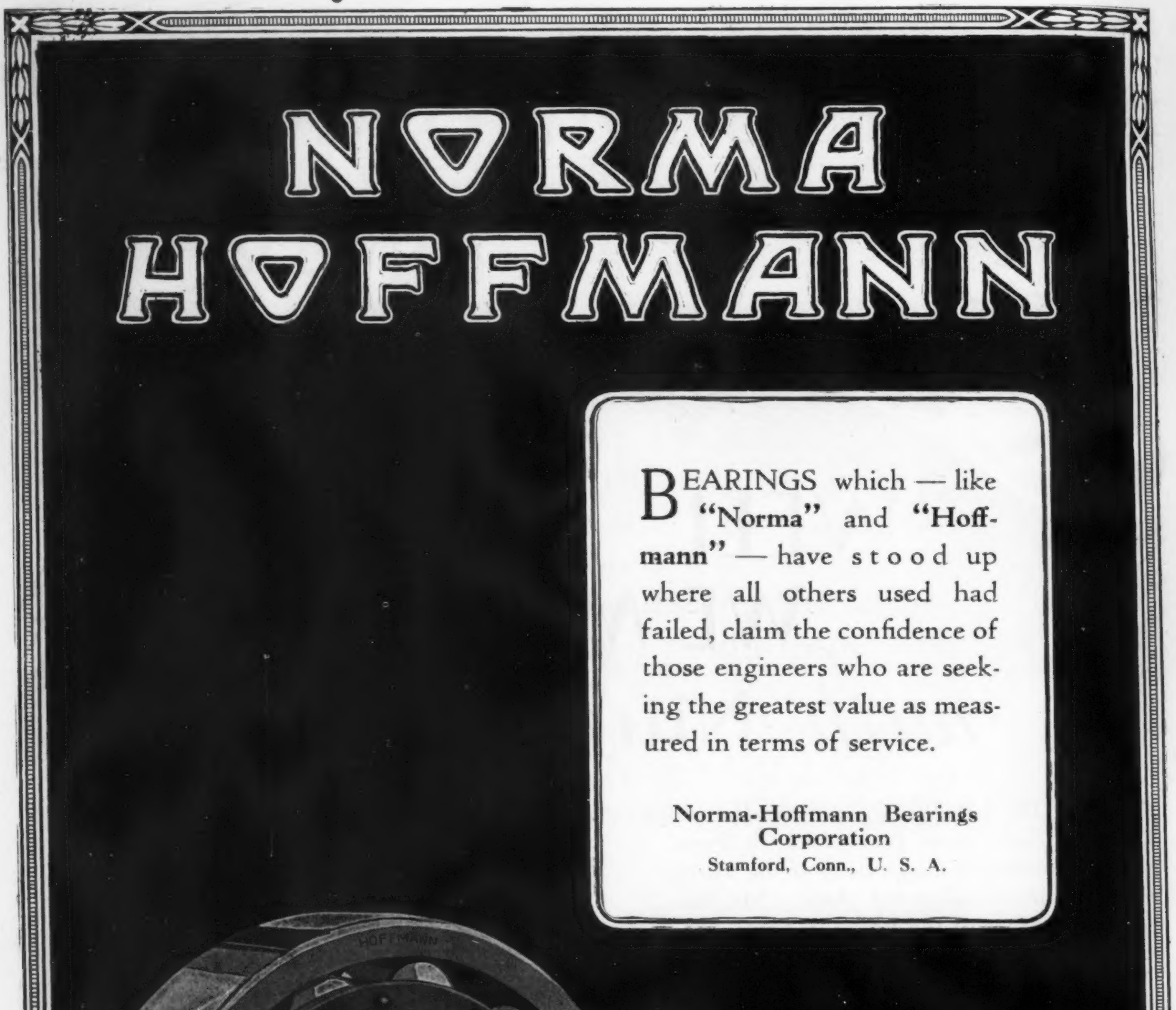
BRAKE REPAIRMEN

The next time you need brake lining, *buy Grafild.* Let us give you complete information on "Service Testing" and Grafild Brake Lining—More profits for you.

WORLD BESTOS CORPORATION

52 Courtland Street, Paterson, N. J.

"Holds Wet or Dry"—"Holds Wet or Dry"


NORMA
HOFFMANN
BEARINGS which — like "Norma" and "Hoffmann" — have stood up where all others used had failed, claim the confidence of those engineers who are seeking the greatest value as measured in terms of service.
Norma-Hoffmann Bearings Corporation
Stamford, Conn., U. S. A.
HOFFMANN
N-28


RUSTPROOF
KANTLINK Lock Washers are non-corrosive as well as non-linkable.
They are made rustproof by Parkerizing. This process converts the surface of the lock washer into a basic iron phosphate which is absolutely impervious to corrosion. As a result, KANTLINK Lock Washers are permanently rustproof. They will not rust in the store room, on cars, trucks or other equipment.
The National Lock Washer Co.
General Offices:—Newark, N. J.
Plants:
Newark, N. J., Riverside, N. J., Milwaukee, Wis.
KANTLINK
REGISTERED
PATS. PENDING
LOCK WASHERS

A part of California's rugged shore line. © DETROIT PUBLISHING CO.

When the Rush is on

AND every effort is bent toward greater production speed . . . the Duco finishing system comes into its own. All along the finishing line the Duco system speeds up production.

Pyroxylin Surfacer air dries faster, sands easily, and eliminates cripples.

Chassis Lacquer gives the chassis a finish life comparable to the Duco body and is applied with the same speed as Duco.

Striping with Duco permits the car to be shipped the same day when necessary and saves space on the finishing floor which would be taken up by cars waiting for striping to dry.

When using the complete Duco system there is no weak link in the chain. All departments progress at the same high speed.

DU PONT DUCO

REG. U.S. PAT. OFF.

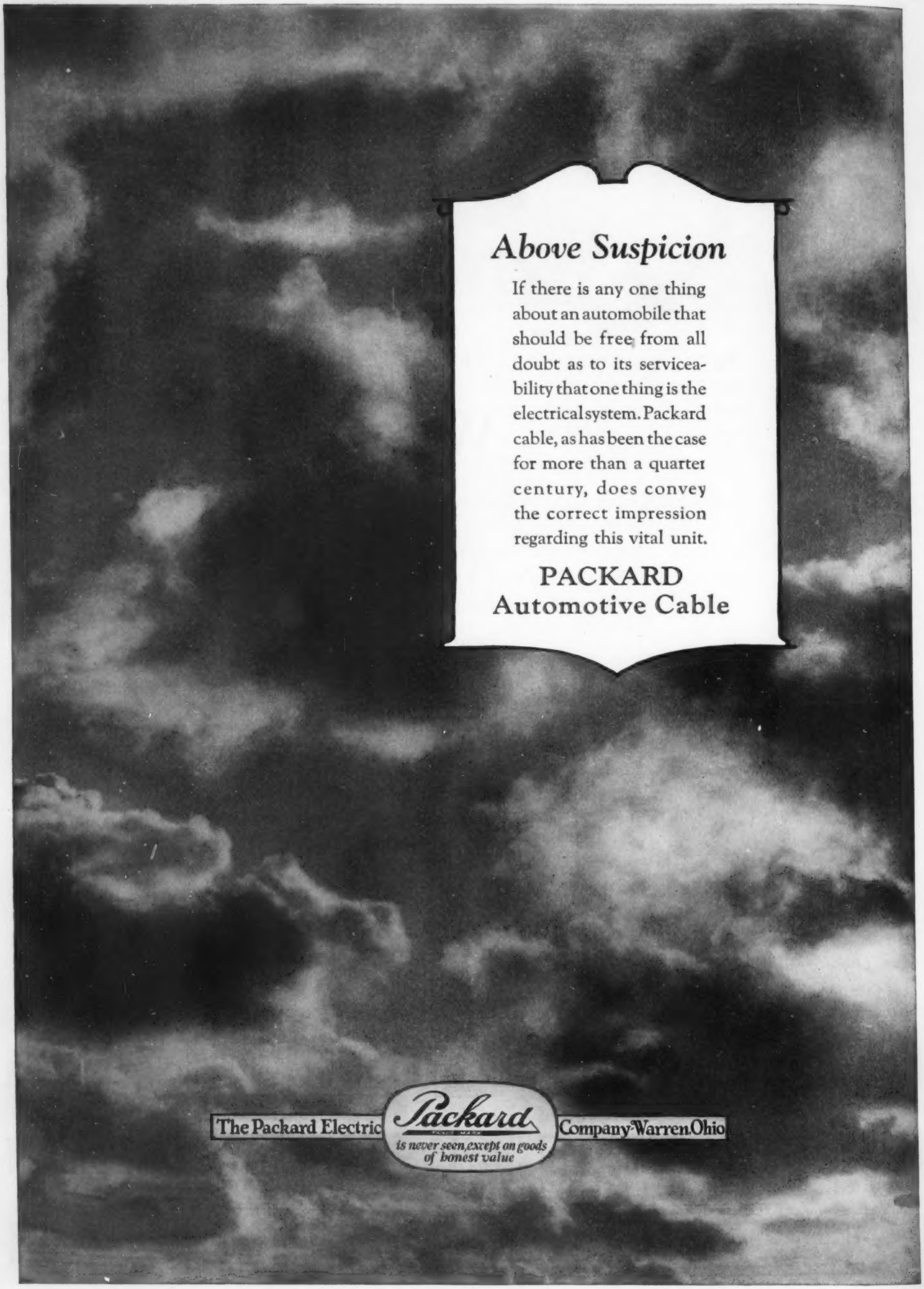
There is only ONE Duco . . . DU PONT Duco

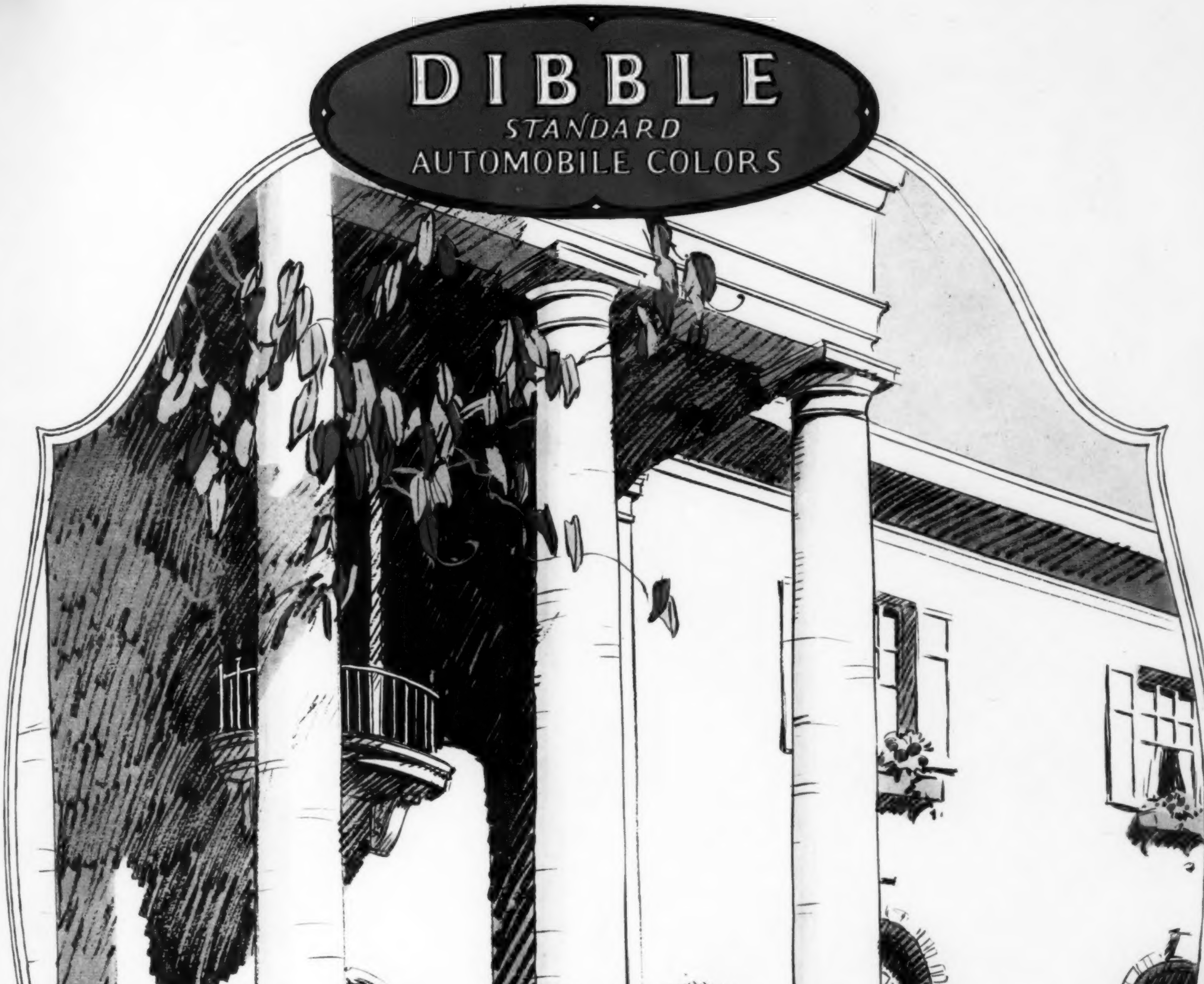
E. I. du Pont de Nemours & Co., Inc., Chemical Products Division, Parlin, N. J., Detroit, Mich., Chicago, Ill., San Francisco, Cal., Everett, Mass., or Flint Paint and Varnish Limited, Toronto, Canada.

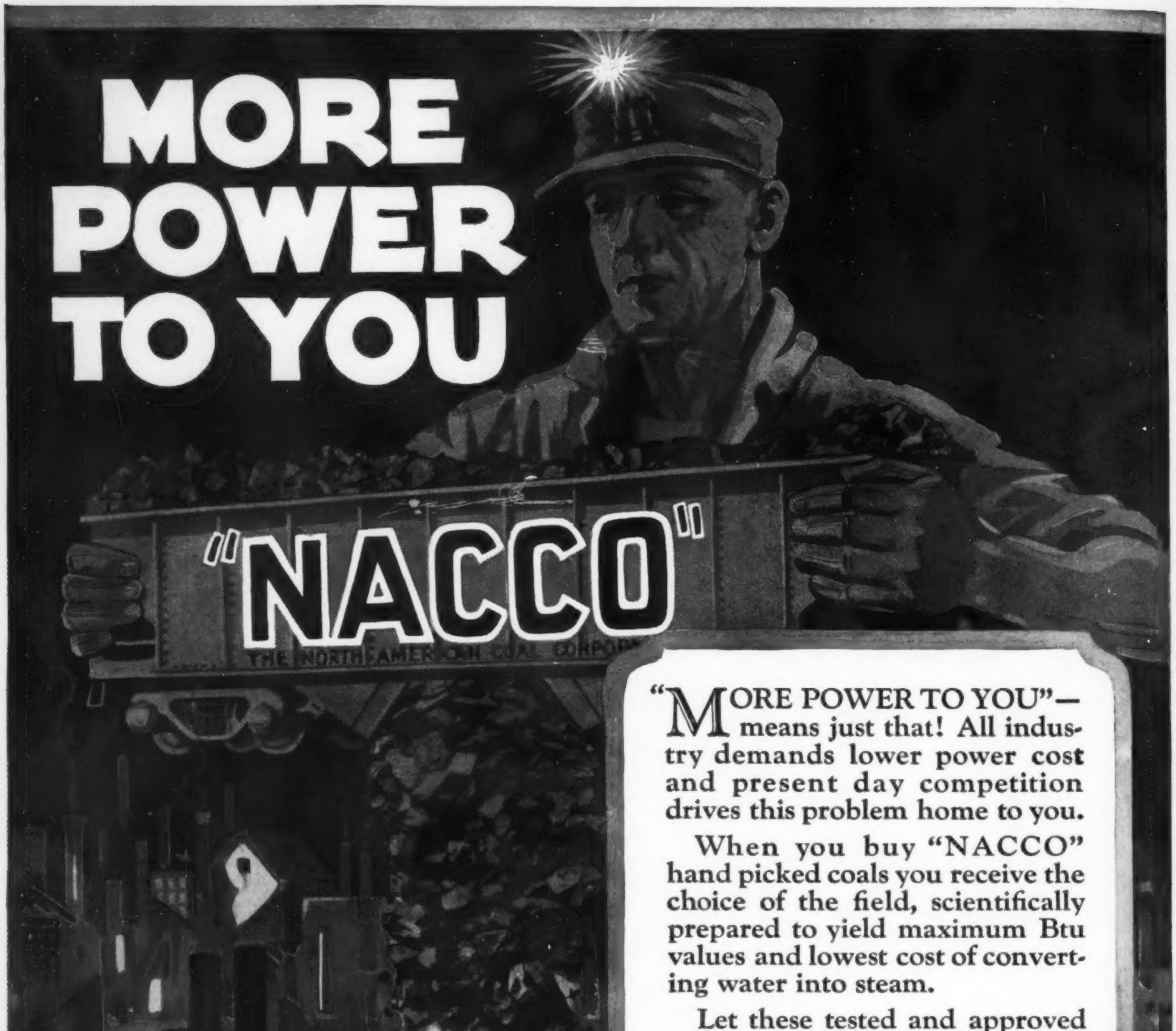
Buick · Oakland · Nash · Kissel · Franklin · Chrysler · Cadillac · Kleiber · Hudson

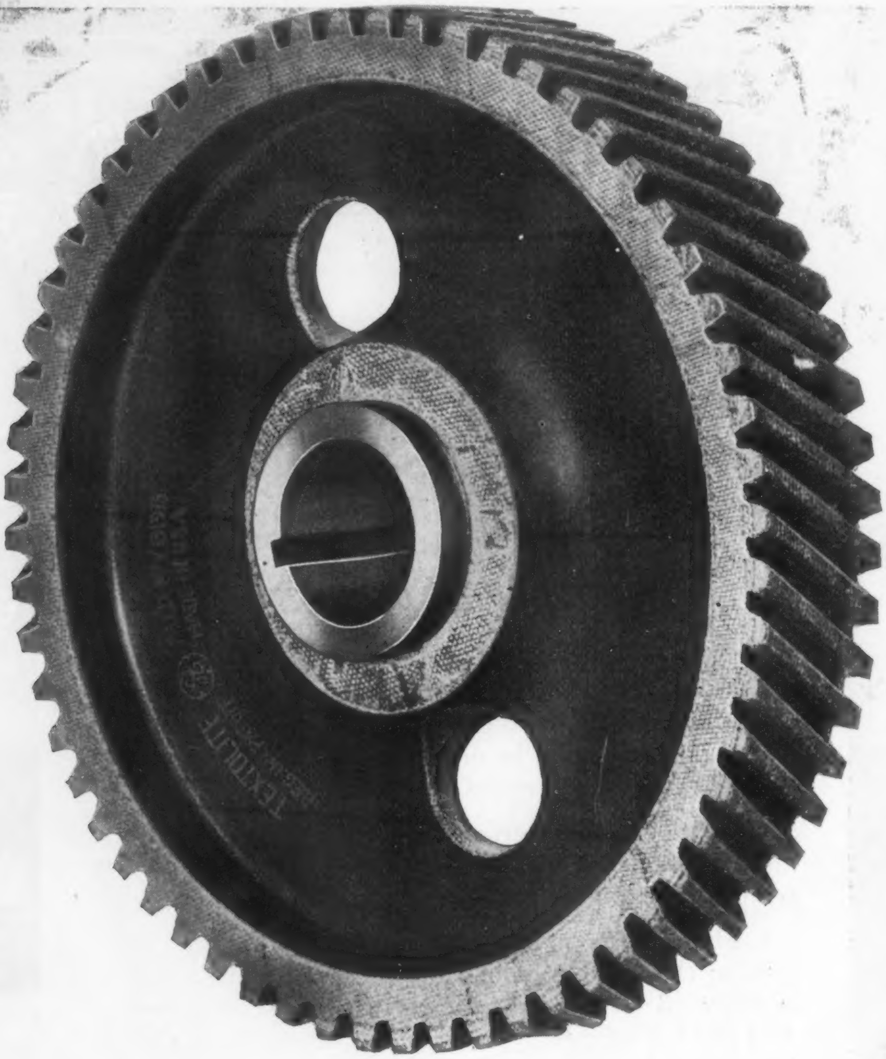
Chevrolet · Oldsmobile · Hertz · H · Marmon · Meteor · Hercules · Locomobile · Stutz 8

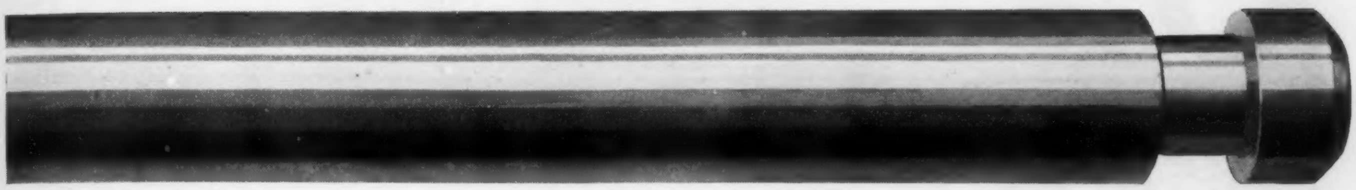
Y · McFarlan · Pontiac · Essex Motors · Voisin · La Salle · Bugatti · Renault · Delage

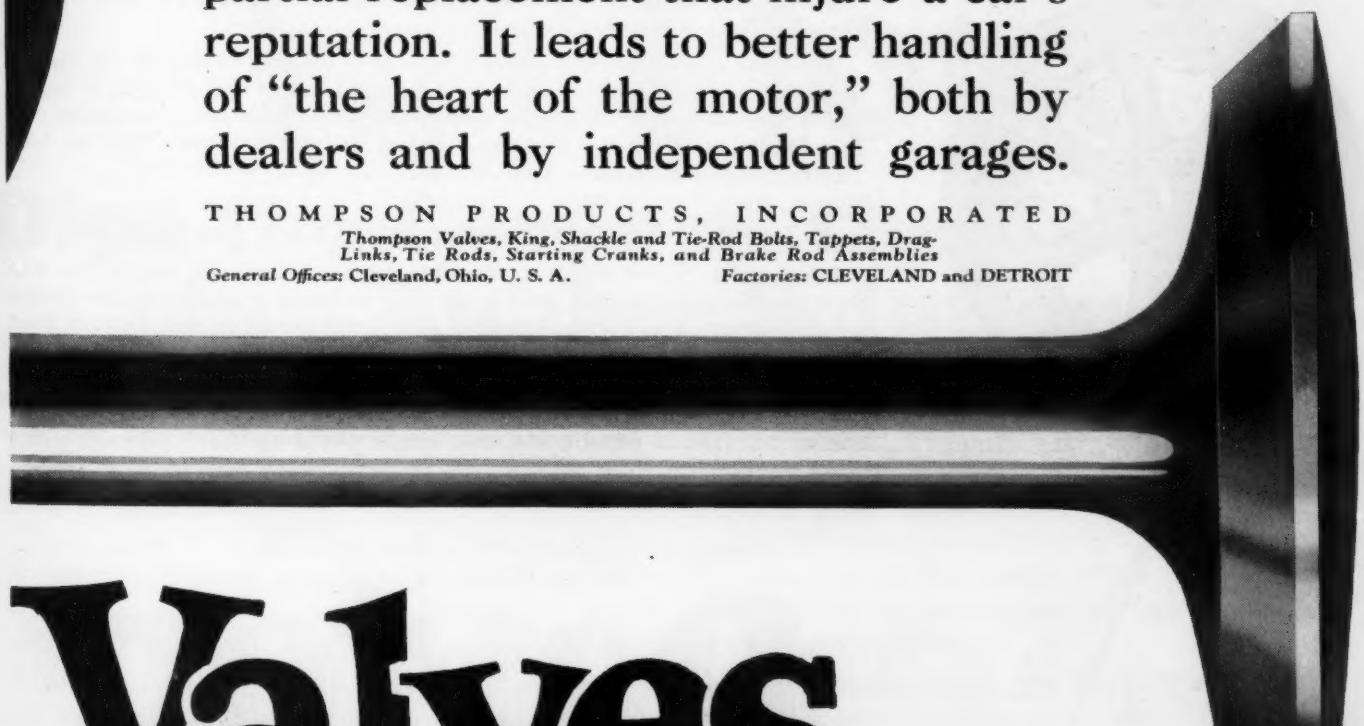

Above Suspicion
If there is any one thing about an automobile that should be free from all doubt as to its serviceability that one thing is the electrical system. Packard cable, as has been the case for more than a quarter century, does convey the correct impression regarding this vital unit.
PACKARD
Automotive Cable
The Packard Electric
Packard
is never seen, except on goods of honest value
Company-Warren, Ohio

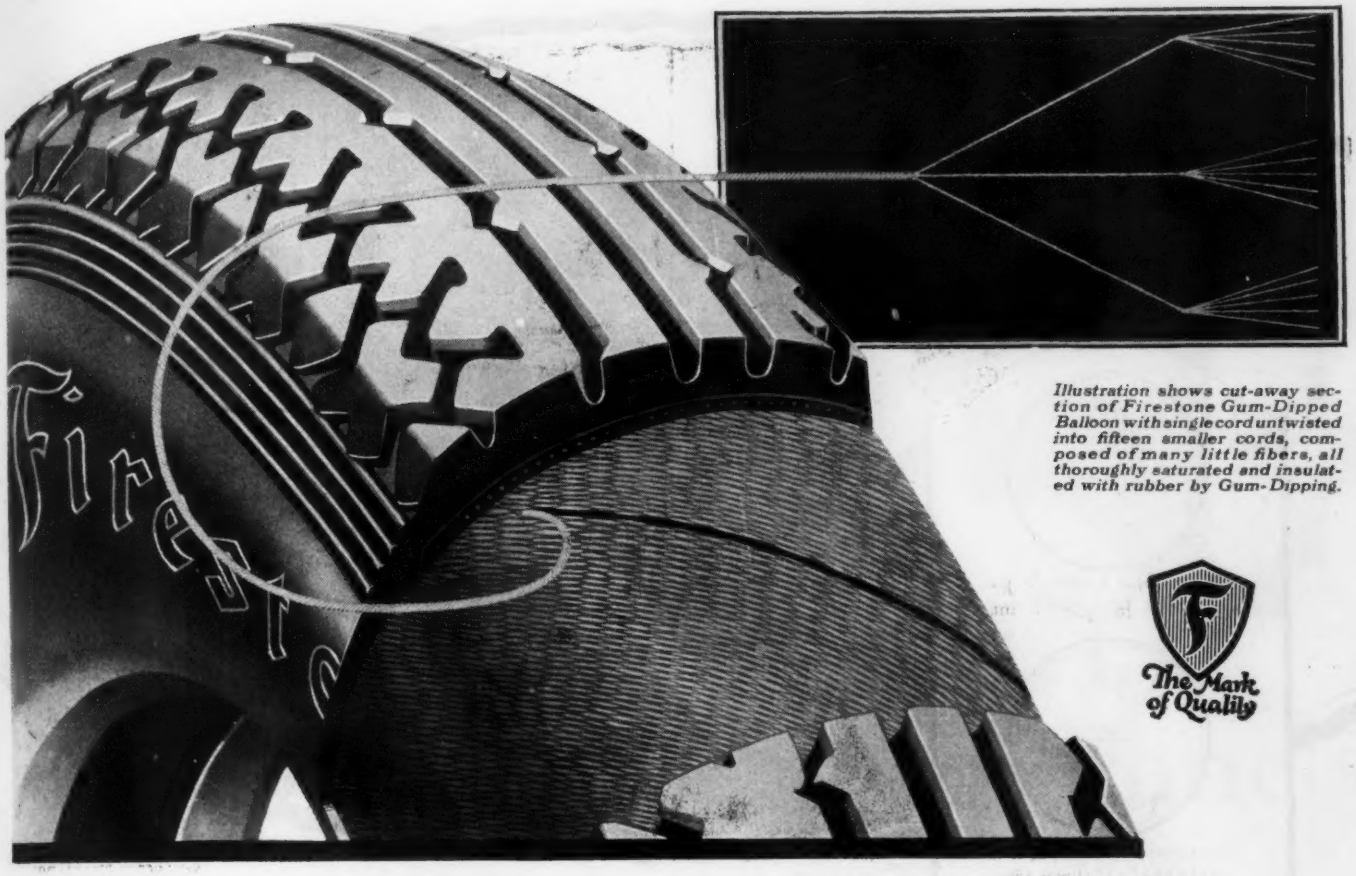

DIBBLE
STANDARD
AUTOMOBILE COLORS


MORE POWER TO YOU
"NACCO"
"MORE POWER TO YOU"—means just that! All industry demands lower power cost and present day competition drives this problem home to you.
When you buy "NACCO" hand picked coals you receive the choice of the field, scientifically prepared to yield maximum Btu values and lowest cost of converting water into steam.
Let these tested and approved coals solve YOUR fuel problems:
Pittsburgh Terminal Youghiogheny Gas
Pittsburgh Steam Powhatan
Atwater Pocahontas Pittsburgh No. 8
Southern West Virginia and Eastern Kentucky Gas, By-Product, Steam and Domestic Coals
Pittsburgh Terminal Special Coal for Water Gas Generater Use
Castle Shannon and Saw Mill Run Gas Coals
FIFTEEN MILLION TONS ANNUALLY
from the Principal Bituminous Fields
2nd Nat. Bank Bldg. Toledo, O.
Prudential Bldg. Buffalo, N.Y.
2nd Nat. Bank Bldg. Akron, O.
THE NORTH AMERICAN COAL CORPORATION
Wabash Bldg. Pittsburgh, Pa.
Canada Coal Ltd., Toronto, Sault Ste. Marie and Montreal
No. 1 Broadway New York City
UNION TRUST BLDG. CLEVELAND, OHIO
AFFILIATED COMPANIES:
THE INLAND COAL & DOCK CO. Minneapolis and Duluth, Minn.
THE UNITED COAL & DOCK CO. Milwaukee, Wisconsin
NACCO STEAMSHIP LINE, INC. Cleveland, Ohio









"That is what brings our costs down, Mr. Leonard."

DAHLSTROM CUSHION RETAINERS fit quickly into place.

DAHLSTROM CUSHION RETAINERS have sharp, clean angles.

DAHLSTROM CUSHION RETAINERS hold their shape.

DAHLSTROM, in metal products, has meant QUALITY for more than twenty years.

Dahlstrom automobile mouldings include

Glass Channels
Cushion Retainers
Door Caps
Finishing Mouldings
Floor Mouldings
Garnish Mouldings
Instrument Panels
Wainscot Panels
Windshield Tubing, Etc.

Where ACCURACY *means* ECONOMY

EVERY Dahlstrom cushion retainer fits smoothly and exactly into place. That means swifter work. That means time and money saved.

In the automotive field Dahlstrom products—garnish mouldings, instrument panels, cushion retainers—have won themselves a reputation for quality, workmanship and the accuracy that helps bring down costs.

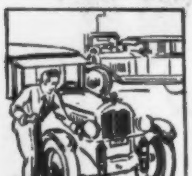
DAHLSTROM METALLIC DOOR CO.
INCORPORATED 1904
JAMESTOWN, NEW YORK

NEW YORK, 475 FIFTH AVE. CHICAGO, 19 SO. LA SALLE ST.
PHILADELPHIA, 514 BULLETIN BLDG.
CLEVELAND, 684 THE ARCADE
DETROIT, 5-251 GENERAL MOTORS BLDG.
Representatives in principal cities

DAHLSTROM PATENT DOOR ARTISTIC EVERLASTING SANITARY AND FIREPROOF

DAHLSTROM
Metal Shapes & Mouldings

STOP
Chasing Phantoms



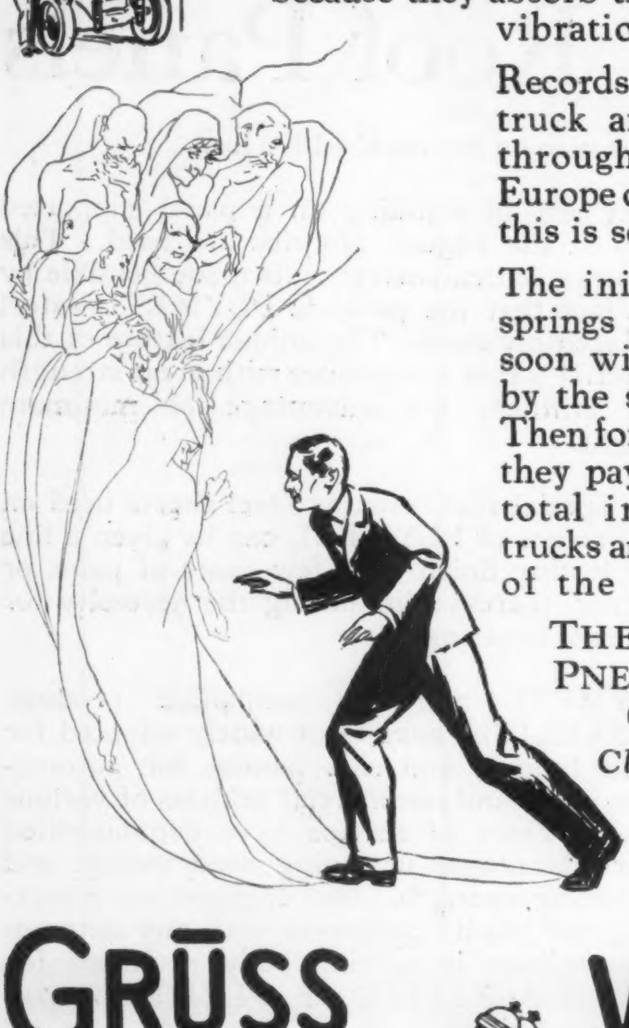
DON'T Look for Lost Profits in the Books When the Answer can be Found on the Front of the Chassis.

Too high maintenance cost and delays and lay-ups due to breakage are what steal the profits that any truck or bus operator has every right to expect.

Air springs eliminate these profit stealers because they absorb the road shocks and vibration that cause them.

Records from thousands of truck and bus operators throughout America and Europe definitely prove that this is so.

The initial expense of air springs is small and this is soon wiped out altogether by the savings they effect. Then for month after month they pay dividends on the total investment of the trucks and buses. The chase of the phantom is over.

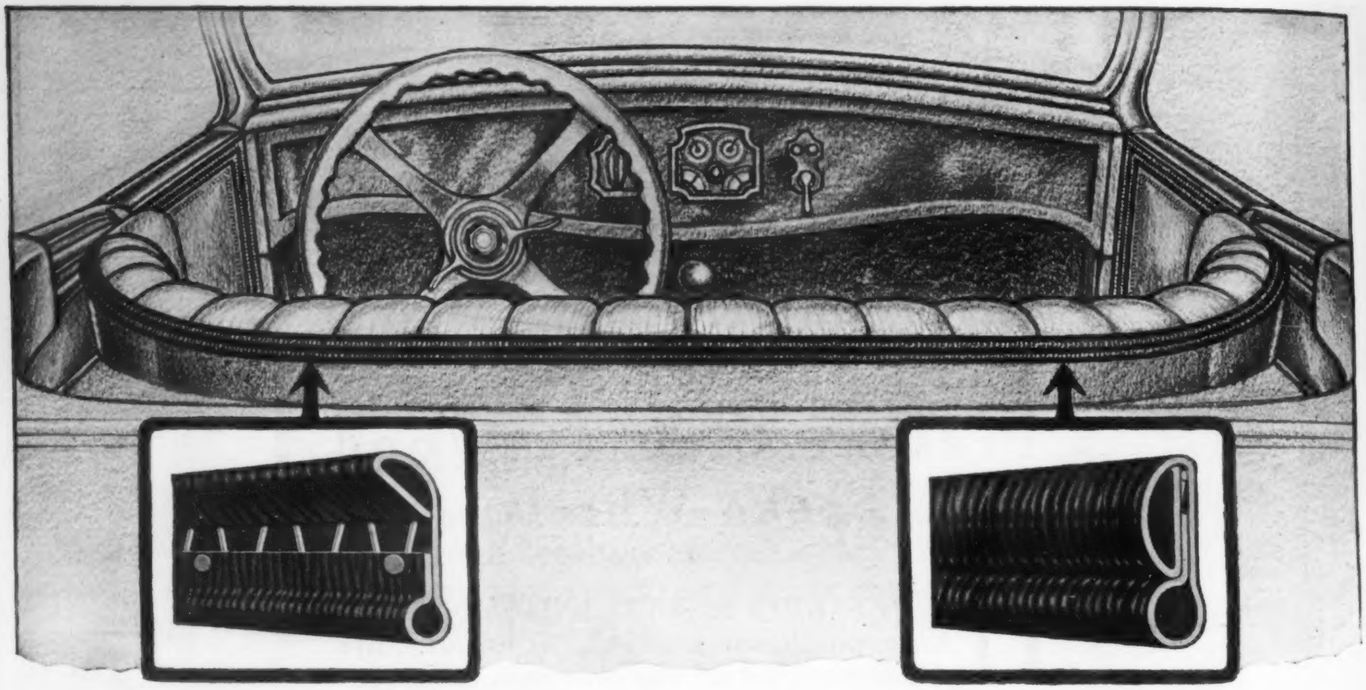


THE CLEVELAND PNEUMATIC TOOL COMPANY
Cleveland, Ohio

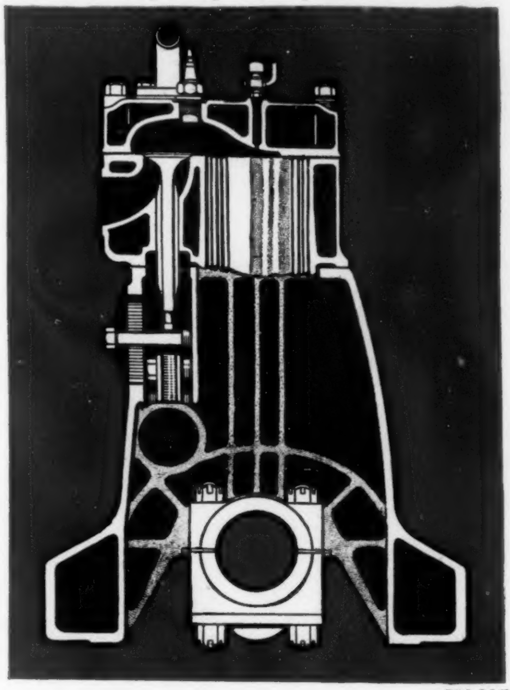
GRŪSS
Sleeve Type
AIR SPRING

WESTINGHOUSE
Piston Type
AIR SPRING

THE SHOCK ELIMINATORS FOR TRUCKS-BUSSES-PASSENGER CARS



Waukesha Heavy Duty Six Cylinder Construction



a-723-MC

Engines Designed to Stand Up

There is no compromise position. An engine either drives a bus 300,000 miles without trouble or it does not. Often engines are purposely under-powered so that they will stand up but they lack acceleration, speed and fuel economy. No such compromises enter the design of Waukesha "Ricardo" Head six cylinder Bus and Truck engines. Equipped with a "Ricardo" head they give —"valve in the head" power without sacrificing their "Ell" head simplicity—almost touring car mileage with a bus—"pingless" performance.

No ordinary engine design can utilize the advantages of "Ricardo" combustion to the fullest. Much more rigid construction is required—an oversize crankshaft and an extra rigid crankcase. Beside the 3½ inch crankshaft Waukesha Six Cylinder Bus engines have a "Girder" type crankcase—arch ribbed as shown above—reinforced torsionally by tubular longitudinal members on each side and a long vertical slab behind the valve tappets that helps tie the four cross walls together. Such rigidity eliminates objectional vibrations and makes dampeners and auxiliary flywheels unnecessary. Write for Bulletin No. 592 describing this engine more fully.

A-723-LC)

AUTOMOTIVE EQUIPMENT DIVISION

WAUKESHA MOTOR COMPANY

Waukesha **Wisconsin**

Eastern Sales Offices *Eight W. 40th Street* *New York City*

Exclusive Builders of Heavy Duty Automotive Type Engines for Over Twenty Years

USE THE RIGHT STEEL FOR THE RIGHT PURPOSE

UNION Hymo-

Combines Toughness with both *Easy Machining* and *Rapid Carburizing Properties*

FOR a wide diversity of requirements calling for a tough, ductile steel, Union Hymo offers exceptional economies because it combines the characteristics of being readily machined and rapidly case hardened.

It is a high manganese open-hearth steel without the many disadvantages of Bessemer and open-hearth screw stocks.

Its machining qualities approach Bessemer screw stock, giving a clean, smooth finish that is fully its equal.

Compared with screw stocks or low carbon open-hearth steels, it develops a uniform case to any desired depth and with much more rapid response. Also, its physical properties are found to be superior for machine parts where heat treatment is not required.

Because it speeds up operation of automatics, prolongs life of tools, reduces rejections of finished parts, economizes power and fuel costs and expedites delivery service, Union Hymo Steel fills a long felt need.

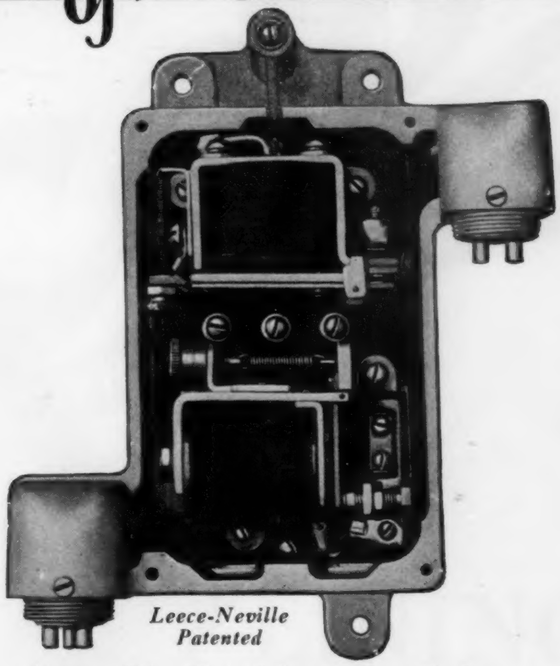
UNION DRAWN STEEL CO. Beaver Falls, Pa.

UNION DRAWN STEELS

HOW THE LONG DAYLIGHT HOURS OF SUMMER~

5.30 A.M. ← Almost 15 hours of daylight → 8.10 P.M.

ARE ALMOST SURE TO OVERCHARGE THE BATTERY!



Leece-Neville Patented

Leece-Neville Voltage Regulation prevents this possibility

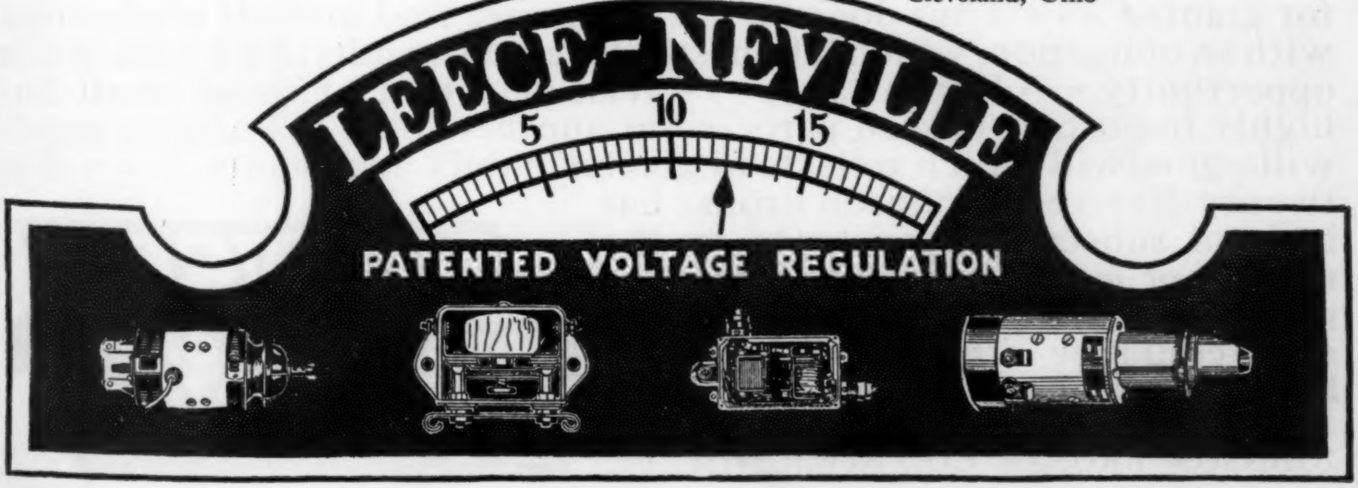
Voltage Regulation Minimizes Electrical Maintenance

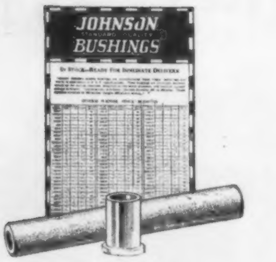
1. Battery cannot be overcharged.
2. Battery is charged only at the correct rate for its state of charge.
3. Battery will operate longer without requiring replenishing of electrolyte.
4. Life of battery greatly prolonged.
5. Lights can be operated direct from generator.
6. Loose connections will not cause lamp bulbs to burn out.
7. Generator will not burn out even if run with battery removed.
8. Lamp life greatly prolonged.
9. Provides passengers with satisfactory illumination and safer transportation.

It's the long hours of operation—incessantly charging the battery without using the lights—that proves the need of voltage regulation. With Leece-Neville Voltage Regulated Electrical Systems, batteries are never overcharged, generators are never burned out. There is no dangerous voltage rise as some connection jars loose. Fewer lamps are replaced. The vehicle may be operated entirely WITHOUT THE BATTERY.

Adopted by truck and bus builders in ever-increasing numbers because proven practically trouble-free. Specify Leece-Neville Voltage Regulation on your next purchase.

The Leece-Neville Company
Cleveland, Ohio





Warehouses at
CHICAGO
KANSAS CITY
SAN FRANCISCO

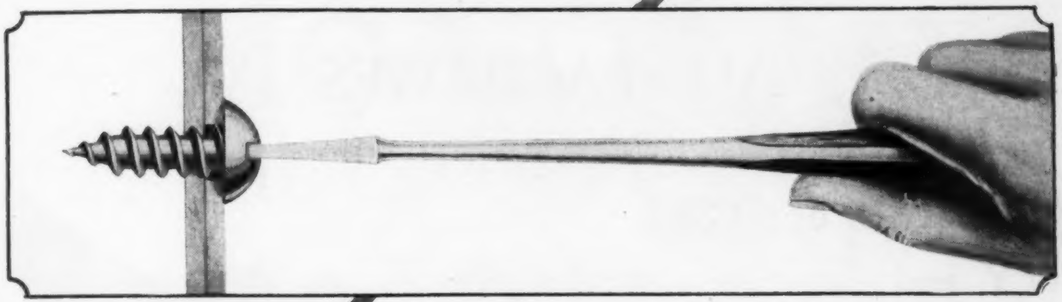
Where Obligation Is Opportunity

First opinions of an automobile are governed largely by its outward appearance, what friends and neighbors have to say about it, and the claims made for it by the maker • • • The new owner has faith that his purchase will perform over a satisfactory period of time in an acceptable manner • • • That it will give him a minimum of trouble, he takes for granted • • • Thus does the manufacturer find himself confronted with an obligation, which if honestly accepted, results in a worth-while opportunity • • • For instance • • • Wise selection of those small but highly important unseen parts is but another form of building good-will—goodwill which reflects in greater public acceptance • • • For twenty-five years Johnson Bronze has been of substantial assistance to the makers of motor vehicles, helping to make sure that no inferior performance could be attributed to bronze bushing and bearing equipment.

JOHNSON BRONZE CO., New Castle, Pa.

JOHNSON
QUALITY BRONZE
BUSHINGS

These self-tapping screws make substantial fastenings to sheet metal!



Easier

because they are used in sheet metal like wood screws are used in wood. There's nothing simpler.

Quicker

because you can make a first-class fastening with these screws in half the time and with a fraction of the effort that other methods require.

Cheaper

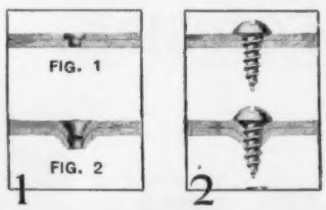
because they eliminate taps and tapping operations and save from 50% to 75% of the cost of making sheet metal assemblies by any other means

PARKER-KALON Hardened Self-Tapping SHEET METAL SCREWS offer an easier, quicker and cheaper method of making sheet metal assemblies. They make better—stronger—fastenings than machine screws, stove bolts, etc.—fastenings that won't readily loosen under vibration.

These Screws cut their own thread in the metal as they are screwed in, thus eliminating the costly tapping operation with its breakage of taps and upkeep of tapping machinery.

Easy to use—no skill required.

1st. Punch or drill a hole as in Fig. 1; or pierce a hole as in Fig. 2.



2nd. Turn in the Screw with a screw driver

Automobile manufacturers and body builders producing 85 per cent. of the total volume of cars, are using millions of these Screws for fastening upholstery fabric, attaching door pads, remote control units, windbreaks, visors, trim sticks, garnish rails, mouldings, anti-squeak, windshield brackets, etc. These are just a few of the many assemblies that are being made easier, quicker, cheaper and better with Parker-Kalon Hardened Self-Tapping Sheet Metal Screws.

Can be furnished in sizes to suit all requirements.

PARKER-KALON CORPORATION, 360 West 13th St., New York

PARKER-KALON
HARDENED SELF-TAPPING
Sheet Metal Screws

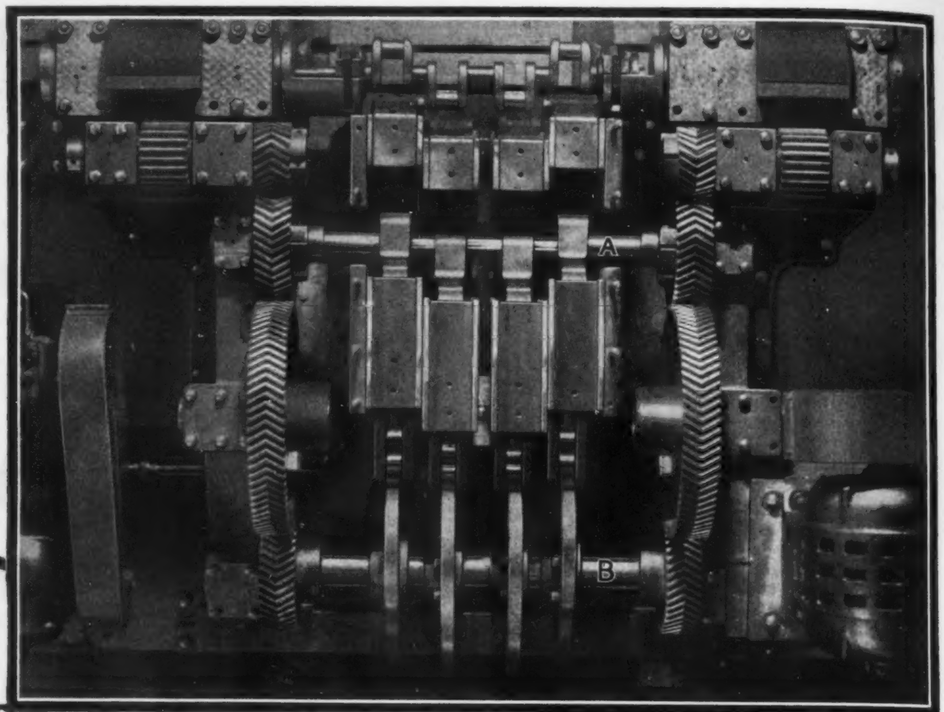
(PAT. APRIL 1, 1919 — MARCH 28, 1922
AUGUST 14, 1923 — FEBRUARY 10, 1925)

Prove this yourself!

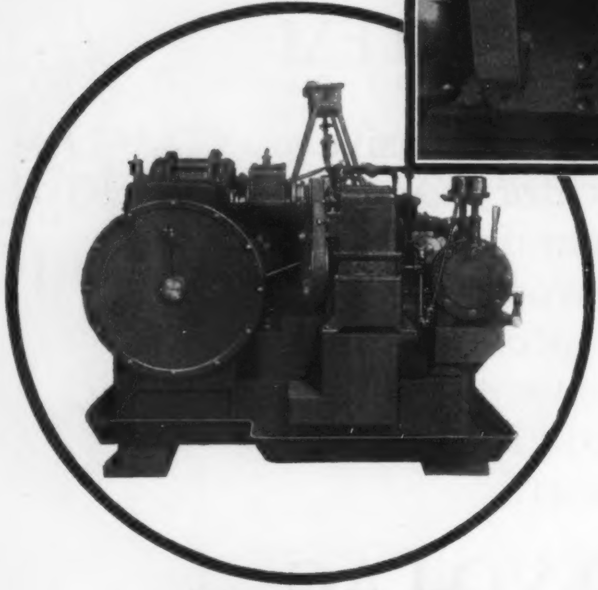
Let us send you free samples of these time - and - labor - saving Screws for test. Learn why they are so extensively used by the automotive industry. Write to

PARKER-KALON CORPORATION
355 W. 13th St., New York, N. Y.

Overhead view of Melling contour lathe with cover removed, showing method of controlling cutting tools. "A" shows master which controls in-and-out movement of tools. "B" the cams and connecting links which control angular relation of tools to work.



Showing left end of machine. Semi-automatic; completes the cycle and stops in position to unload.



Reduce Your Labor Costs
with the Melling Crankshaft Contour Lathe

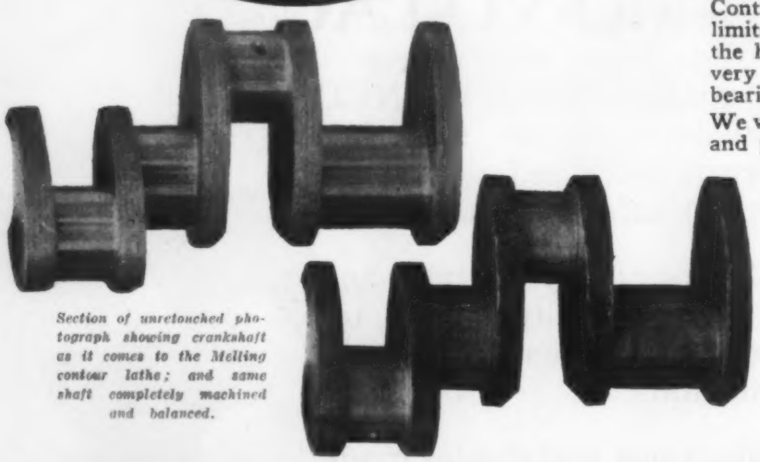
The trend in recent years in the internal combustion engine industry has been toward crankshafts with the largest possible number of bearings. The actual balancing of such crankshafts by hand has been a matter of expensive testing and removal of metal.

The Melling contour lathe completely machines the periphery of webs at greatly reduced cost; and so accurately does it work that the expense of hand balancing is quite largely removed.

Controls diameter, plane, and index within very close limits. The oil gear feeds give a much *finer finish*; the hydraulic pressure holds the tools into the work very smoothly and uniformly. Semi-automatic. All bearings automatically gravity oiled.

We will gladly furnish complete specifications, photos and production estimates on request.

You need this labor saving machine—better investigate.



Section of unretouched photograph showing crankshaft as it comes to the Melling contour lathe; and same shaft completely machined and balanced.

WALCOTT MACHINE CO.
(Formerly Walcott Lathe Co.)
Factory and Main Office: Jackson, Mich.

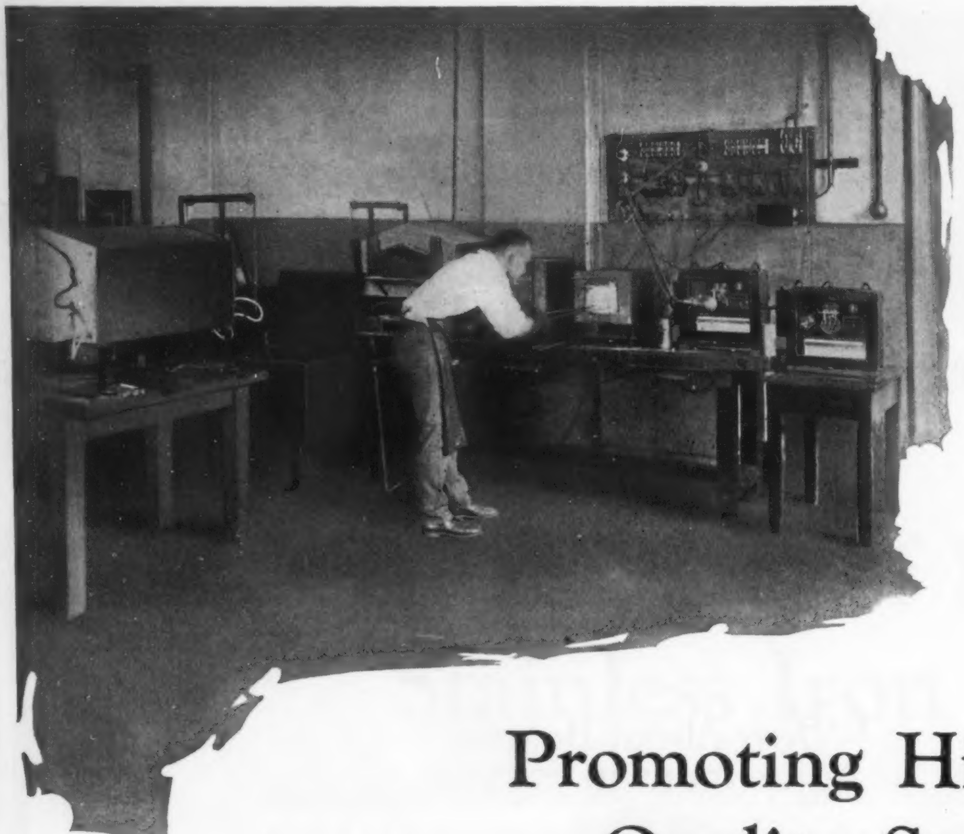
Detroit Office:
3-129 General Motors Building

Manufacturers of
Gear Grinders
Camshaft Lathes
Crankshaft Contour Lathes
and **Gear Burring Machines**

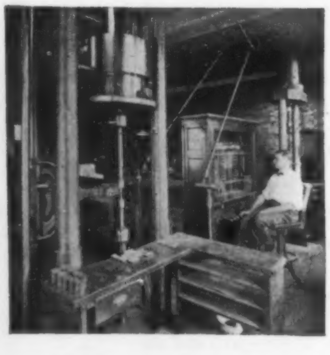
Precision Machines for the Automotive Industry

walcott

Interior of Blast Furnace Cast House in Central Alloy Plant



Determining correct heat-treatment for Alloy Steels.



Emery Testing Machine used in determining tensile properties of Alloy and Tool Steels.

Available Specifications and Reports

Reports of interest to the automotive industries. Those marked with an asterisk (*) may be had from S.A.E. stock. For further information, address the Society. Prices subject to change without notice.

S.A.E. STANDARDS AND RECOMMENDED PRACTICES

*S. A. E. HANDBOOK $5.00

SECTIONAL COMMITTEE REPORTS

Approved Under the Rules of Procedure of the American Engineering Standards Committee.

***B1a—1924 SCREW THREADS FOR BOLTS, MACHINE SCREWS, NUTS AND COMMERCIALLY TAPPED HOLES** .... .50
Sponsors—Society of Automotive Engineers. American Society of Mechanical Engineers.
NOTE—The report includes the Loose, Free, Medium and Close Fits for coarse and fine-pitch threads. The Free, Medium and Close-Fit classes of threads have been adopted as S. A. E. Standard and are included in the S. A. E. Handbook.

B2—1919 PIPE THREADS .... .40
Sponsors—American Gas Association. American Society of Mechanical Engineers.

B4a—1925 TOLERANCES AND ALLOWANCES FOR MACHINED FITS IN INTERCHANGEABLE MANUFACTURE .... .50
Sponsor—American Society of Mechanical Engineers.

B7—1926 SAFETY CODE FOR USE, CARE AND PROTECTION OF ABRASIVE WHEELS (Revised) .... .05
Sponsors—Grinding Wheel Manufacturers of U. S. and Canada. International Association of Industrial Accident Boards and Commissions.

B8—1922 SAFETY CODE FOR PROTECTION OF INDUSTRIAL WORKERS IN FOUNDRIES .... .10
Sponsor—American Foundrymen's Association.

B11—1926 SAFETY CODE FOR POWER PRESSES, AND FOOT AND HAND-PRESSES (Revised) .... .25
Sponsor—National Safety Council.

B17a—1924 DIAMETERS AND LENGTHS OF COLD-FINISHED SHAFTING .... .20
Sponsor—American Society of Mechanical Engineers.

B17b—1925 SQUARE AND FLAT KEYS FOR SHAFTING .... .20
Sponsor—American Society of Mechanical Engineers.

B18b—1927 WRENCH-HEAD BOLTS AND NUTS AND WRENCH OPENINGS .... .35
Sponsors—Society of Automotive Engineers. American Society of Mechanical Engineers.
NOTE—The report in substantial part has also been adopted as S. A. E. Standard and is included in the S. A. E. Handbook.

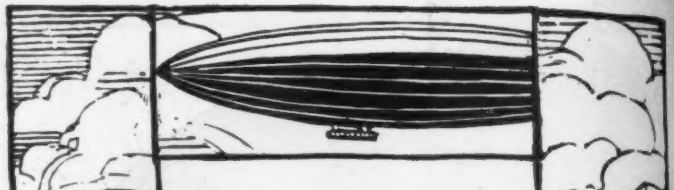
***D1—1925 AERONAUTIC SAFETY-CODE** 1.50
Sponsors—Society of Automotive Engineers. U. S. Bureau of Standards.
NOTE—The Society has approved the report as tentative American Standard but not as S. A. E. Standard. It is not included in the S. A. E. Handbook.

D2—1922 AUTOMOBILE HEADLIGHTING SPECIFICATIONS—LABORATORY TESTS FOR APPROVAL .... .25
Sponsors—Society of Automotive Engineers. Illuminating Engineering Society.
NOTE—The technical specifications in the report have been adopted by the Society and are included in the S. A. E. Handbook.

O1—1924 SAFETY CODE FOR WOODWORKING PLANTS .... .05
Sponsors—International Association of Industrial Accident Boards and Commissions. National Bureau of Casualty and Surety Underwriters.

X2—1922 SAFETY CODE FOR PROTECTION OF HEADS AND EYES OF INDUSTRIAL WORKERS .... .10
Sponsor—U. S. Bureau of Standards.


EISEMANN



Employment Service

The Society endeavors to serve its members as completely as possible in the matter of employment. Approximately 150 men are placed in positions each year through its Employment Service, at salaries ranging from $2,500 to $10,000 or more per year.

Through a system of BULLETINS mailed twice each week, addressed for the personal attention of the General Managers, the Society keeps in touch with approximately 1000 companies of good standing in the industry.

Contact is maintained also with Technical Schools and Publishers of Trade Magazines.

BULLETINS OF POSITIONS AVAILABLE are mailed frequently to members to whom they are of interest.

The Bulletins of Men and Positions Available are mailed regularly to the Secretaries of the Sections of the Society for the purpose of making the Bulletins readily accessible to companies and to members located near the headquarters of the respective Sections.

When requesting that bulletins be sent to you, please specify whether you wish the bulletin of Men Available or that of Positions Available.

There is no charge for this service, to members or companies.

Address:

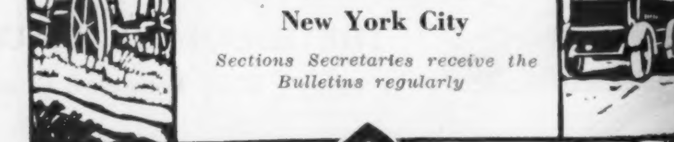
S. A. E. Employment Service

Society of Automotive Engineers, Inc.

29 West 39th Street

New York City

Sections Secretaries receive the Bulletins regularly




Add a Lasting Thrill to any Motor
Stay Put!
BOHNALITE
Bohn Products include Ring True Bearings—Bohnalite Castings, semi-permanent, permanent mold and sand, Nelson Bohnalite pistons; we also supply the government with replacement pistons and bearings for the Liberty engine.

MEMBERS' PROFESSIONAL CARDS

INDEX TO ADVERTISERS' PRODUCTS

Marketed as Conforming With S.A.E. Standards and Recommended Practices, and Products for Which There Are No S.A.E. Standards

(Continued on page 154)

EXPLANATION OF SYMBOLS

Parts and materials followed by key numbers have been standardized by the S. A. E. The numbers refer to S. A. E. HANDBOOK data sheets on which each standard is published.

*Companies whose names are preceded by an asterisk supply the parts or materials under which the company is listed as conforming with the S. A. E. Standard referred to.

**Parts and materials followed by two asterisks indicate that two or more S. A. E. Standards are applicable. Information as to standards incorporated should be obtained from the manufacturer.

The address of companies listed in this index can be obtained from their current advertisements indexed on page 160.

INDEX TO ADVERTISERS' PRODUCTS

(Continued on page 156)

INDEX TO ADVERTISERS' PRODUCTS

(Continued on page 158)

There's a WHY! to MARVEL Carburetion

MARVEL Carbureters are not designed JUST TO ANSWER THE PURPOSE. Every application of Marvel principles is to meet a specific need or to overcome a difficulty that has seemed impossible.

There is a WHY to every single method of design— there is a WHY to every patented feature of improvement, and Marvel possesses several very important ones backed by test and by reason.

A system that Entails Perfect Co-ordination of THE TWO MAJOR DIVISIONS of Carburetion—Metering and Proper Vaporization.

A Carbureter Unit designed to provide efficient metering of the fuel in all phases of engine operation.

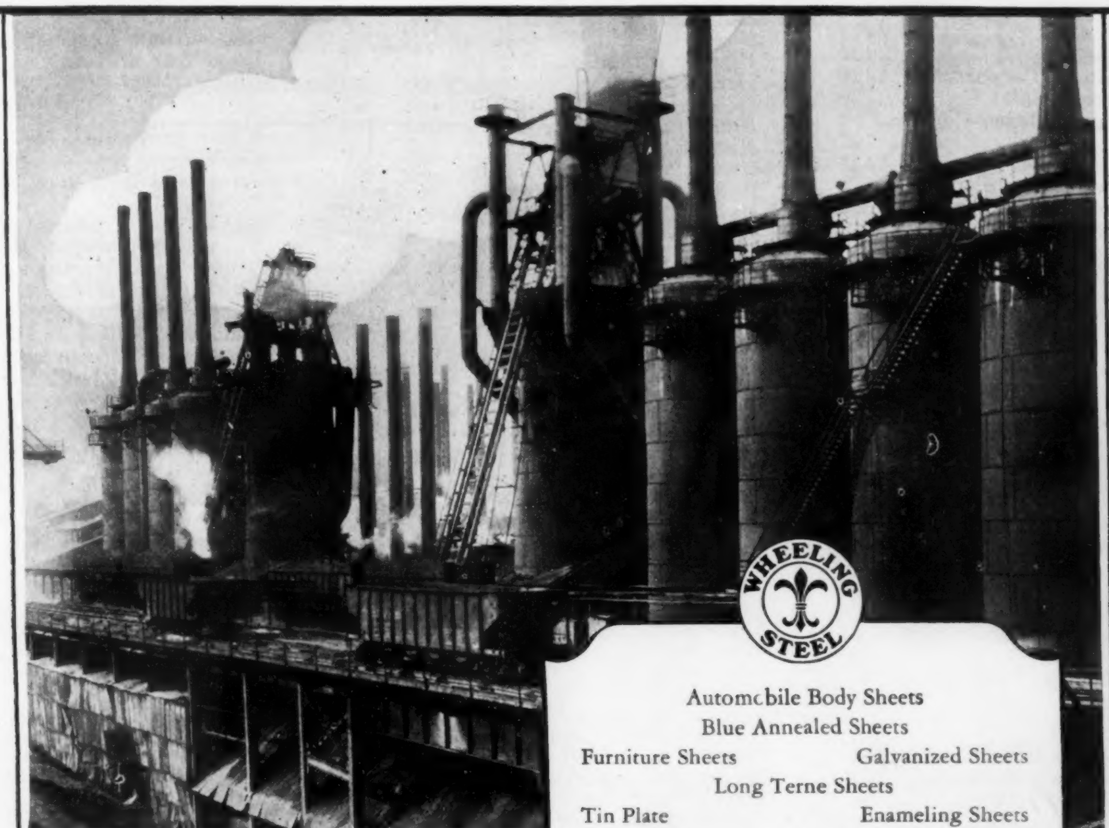
A Vaporizing Unit, utilizing the exhaust gases, designed to automatically control the mixture temperature to any PREDETERMINED requirement. (This range of automatic control provides dry mixture where required and will not reduce the maximum power on wide open throttle.)

MARVEL HEAT CONTROL INSURES MAXIMUM VOLUMETRIC EFFICIENCY AND POWER OUTPUT FROM THE ENGINE AT ALL TIMES.

Buick, Nash, Oakland and Hudson cars are Marvel equipped

Marvel Carbureter Company
Flint, Michigan

INDEX TO ADVERTISERS' PRODUCTS



Blast Furnaces of the Steubenville works supply iron for Open Hearth Steel manufacture, as at other plants of the Wheeling Steel Corporation.

INDEX TO ADVERTISERS

An index to advertisers' products is given on pages 152, 154, 156 and 158